Marine Engineering

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CHESAPEAKE AND OHIO RAILROAD PASSENGER STEAMER VIRGINIA.

The *Virginia* is a twin screw passenger boat of about seven hundred tons displacement, and was built by the William R. Trigg Company, of Richmond, Virginia, on their own plans and specifications. The contract was signed in August, 1901, and she was turned over to the Chesapeake and Ohio Railroad Company in January, 1902.

She is to rate A1 for 20 years, according to the U. S. Standard Registry of Shipping. The speed guaranteed was 18 knots, to be maintained over a measured course.

Stern post cast steel, tensile strength at least 52,000 pounds per square inch.

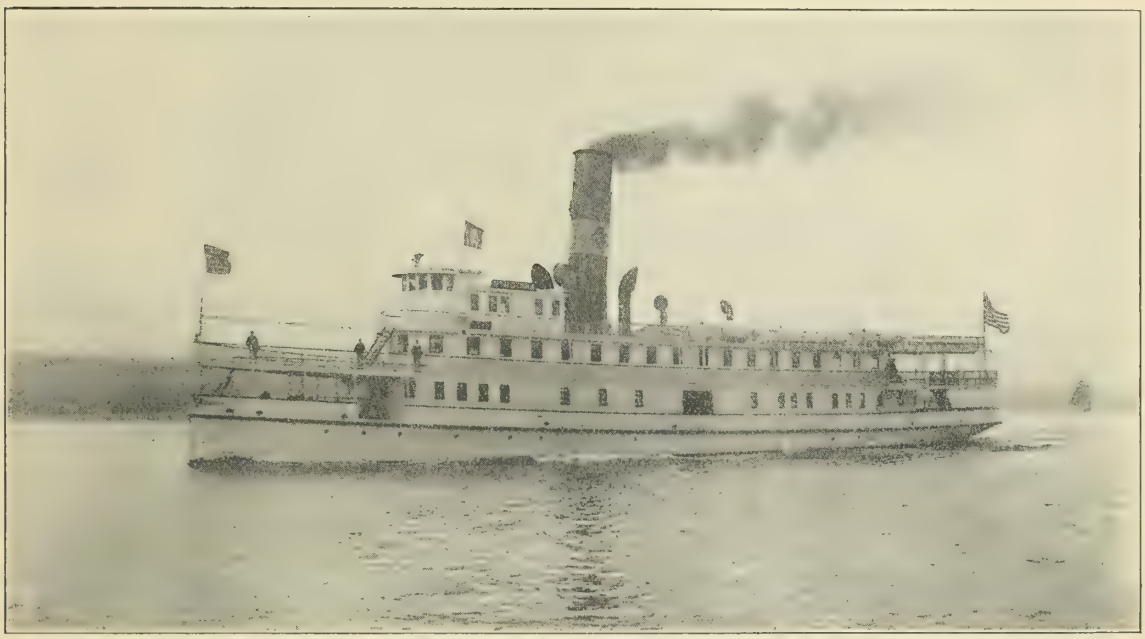
Sheer strake 40 inches wide, 20-pound plate for one-half length amidships, reduced to 15 pounds at ends.

Bilge, side and bottom plating, 15 pounds for one-half length, reduced to 10 pounds at ends.

Doubling plates worked for about ten feet abaft stem, along load water line. Bulwarks 7 1-2 pounds.

Main deck 3-inch yellow pine, other decks 1-inch yellow pine, tongued and grooved, exposed parts covered with No. 5 cotton duck.

Side lights 9 inches in clear.



STEAMER VIRGINIA BUILT BY THE WM. R. TRIGG CO.

The general dimensions are given in the table at the end of this article.

HULL.

The hull is constructed of open hearth mild steel, of domestic manufacture, of not less than 55,000 pounds or more than 65,000 pounds tensile strength, 26 per cent. elongation in 8 inches, elastic limit one-half ultimate strength, cold bending test 180 degrees without fracture. Rivets to be not less than 56,000 pounds tensile strength.

Following are some of the leading scantlings:

The keel, flat plate type, 24 inches wide.

Center vertical keel, 12 1-2 pound plate, 22 1-2 inches deep.

This boat, made after the design of Mr. J. A. Nelson, superintendent, is an example of a hull without hollow lines. The forward section, just abaft the bow, is club foot; that is very full at the bottom. The dead wood is done away with, avoiding hollow water lines. Consequently the boat drives very well in shallow water, the tendency being always for the boat to seek the surface of the water; the faster she goes the more the tendency to decrease the displacement. The idea has been worked out very well indeed, and the performances of the boat during the trial trip fulfilled the highest expectations of the assembled experts.

The vessel was delivered to the owners complete in every particular, paint work bright and clean, com-

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passes adjusted to boat, all boats and outfit in place, and all in first-class condition.

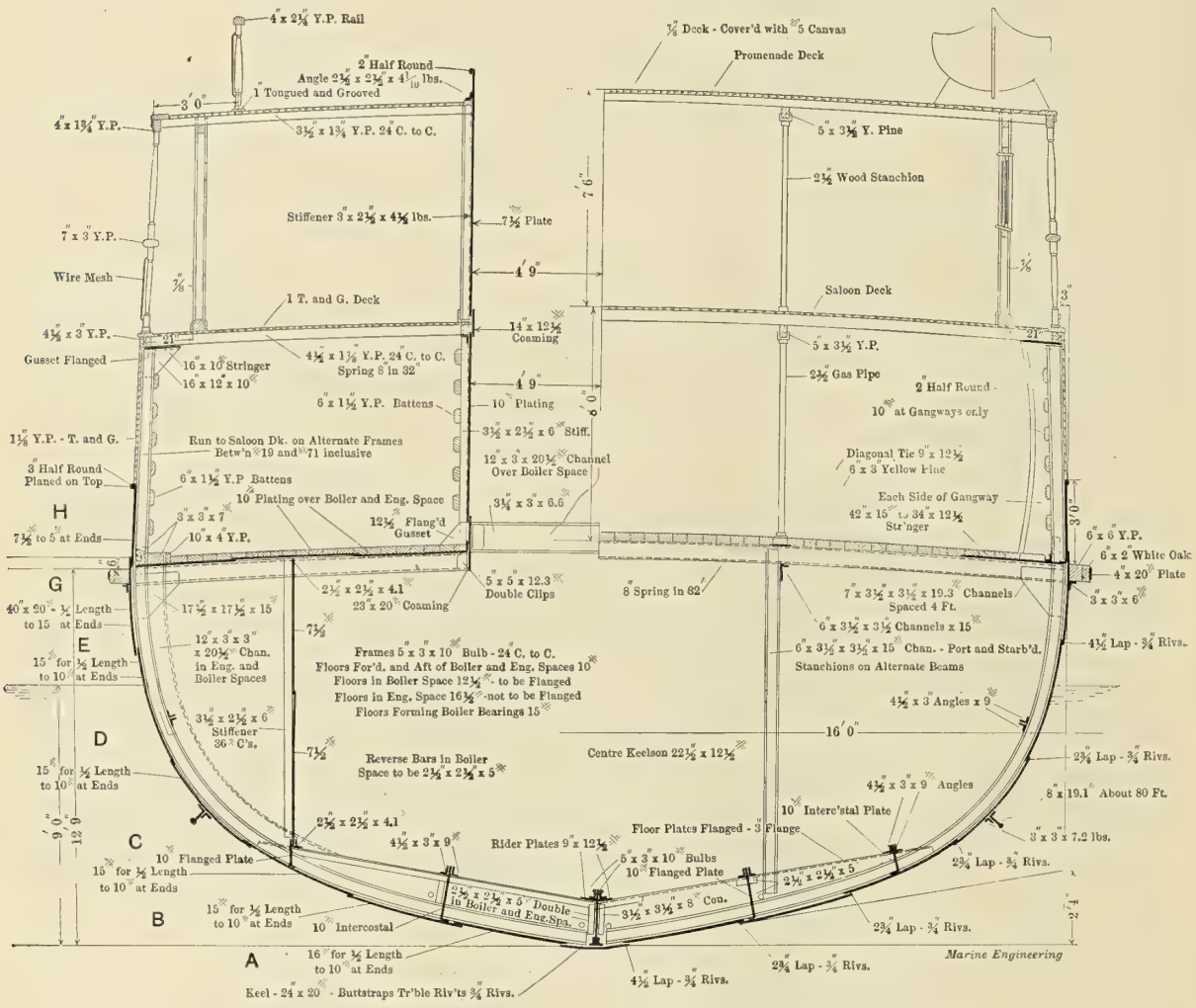
PROPELLING MACHINERY.

There are two vertical, inverted, direct-acting, triple expansion, three-cylinder engines, placed in a common compartment, the two engines side by side, turning inboard. In the cylinder arrangement the H. P. cylinder of each engine is forward and the L. P. aft. The cylinders are supported by forged steel columns at the front and cast iron columns at the back, cast with the condenser, which thus forms a part of the engine framing. Live steam may be admitted to both receivers.

The connecting rods, eccentric and valve rods, and crossheads are of forged steel with high tensile strength.

The go-ahead face of the crossheads is fitted with white metal; the slippers are made of manganese bronze. The ahead guide is of cast iron, bolted to the back columns of the engine, which in turn are cast with the condenser. Cast iron lips are bolted on each side of the ahead guide to take the thrust when backing.

The eccentrics are of combination wrought and cast iron, each in two parts, keyed to the shaft. The eccentric straps are of phosphor bronze, lined with white metal.


4" x 2½" Y.P. Rail
2" Half Round
Angle 2½" x 2½" x 4 10/10 lbs.
1" Tongued and Grooved
3' 0"
4" x 13/4" Y.P.
3½" x 1¾" Y.P. 24" C. to C.
Stiffener 3" x 2½" x 4½ lbs.
7½" Plate
7" x 3" Y.P.
Wire Mesh
7/8"
4' 9"
1 T. and G. Deck
4½" x 3" Y.P.
Gusset Flanged
16" x 10" Stringer
16" x 12" x 10"
4½" x 1⅛" Y.P. 24" C. to C.
Spring 8" in 32"
14" x 12½" Coaming
6" x 1½" Y.P. Battens
10" Plating
3½" x 2½" x 6" Stiff.
1⅛" Y.P. - T. and G.
Run to Saloon Dk. on Alternate Frames
Betw'n 19 and 71 inclusive
3" Half Round
Planed on Top
6" x 1½" Y.P. Battens
12" x 3" x 20½" Channel
Over Boiler Space
10" Plating over Boiler and Eng. Space
H
3" x 3" x 7/16
7½" to 5" at Ends
10" x 4" Y.P.
12½" Flang'd
Gusset
3¼" x 3" x 6.6
2½" x 2½" x 4.1
23" x 20" Coaming
5" x 5" x 12.3
Double Clips
8" Spring in 62"
G
40" x 20" - ½ Length
to 15" at Ends
17½" x 17½" x 15"
7½"
E
12" x 3" x 3"
x 20½" Chan.
in Eng. and
Boiler Spaces
15" for ½ Length
to 10" at Ends
Frames 5" x 3" x 10" Bulb - 24" C. to C.
Floors For'd. and Aft of Boiler and Eng. Spaces 10"
Floors in Boiler Space 12½" - to be Flanged
Floors in Eng. Space 16½" - not to be Flanged
Floors Forming Boiler Bearings 15"
3½" x 2½" x 6"
Stiffener
36" C's.
D
15" for ½ Length
to 10" at Ends
7½"
Reverse Bars in Boiler
Space to be 2½" x 2½" x 5"
Centre Keelson 22½" x 12½"
16' 0"
9' 0"
12' 9"
2½" x 2½" x 4.1
4½" x 3" x 9"
Rider Plates 9" x 12½"
C
10" Flanged Plate
15" for ½ Length
to 10" at Ends
5" x 3" x 10" Bulbs
10" Flanged Plate
2½" x 2½" x 5"
Double
in Boiler and Eng. Spa.
3½" x 3½" x 8" Con.
B
15" for ½ Length
to 10" at Ends
10" Intercostal
A
16" for ½ Length
to 10" at Ends
Keel - 24" x 20" - Buttstraps Tr'ble Riv'ts ¾" Rivs.
4½" Lap - ¾" Rivs.
2¾" Lap - ¾" Rivs.
Marine Engineering
Deck - Cover'd with 5 Canvas
Promenade Deck
5" x 3½" Y. Pine
2½" Wood Stanchion
7' 6"
Saloon Deck
5" x 3½" Y.P.
2½" Gas Pipe
2" Half Round -
10" at Gangways only
Diagonal Tie 9" x 12½
6" x 3" Yellow Pine
Each Side of Gangway
42" x 15" to 34" x 12½
Str'nger
6" x 6" Y.P.
6" x 2" White Oak
4" x 20" Plate
3" x 3" x 6"
7" x 3½" x 3½" x 19.3" Channels
Spaced 4 Ft.
6" x 3½" x 3½" Channels x 15"
6" x 3½" x 3½" x 15" Chan. - Port and Starb'd.
Stanchions on Alternate Beams
4½" Lap - ¾" Rivs.
4½" x 3" Angles x 9"
2¾" Lap - ¾" Rivs.
8" x 19.1" About 80 Ft.
4½" x 3" 9" Angles
10" Intere'stal Plate
Floor Plates Flanged - 3" Flange
3" x 3" x 7.2 lbs.
2¾" Lap - ¾" Rivs.
2¼" x 2¼" x 5"
2¾" Lap - ¾" Rivs.
2¾" Lap - ¾" Rivs.

MIDSHIP SECTION OF THE PASSENGER STEAMER VIRGINIA FOR THE CAPE CHARLES ROUTE.

The main valve for the H. P. cylinder is of the single ported, piston valve type, while those for the I. P. and L. P. are double ported slides. The valve gear is of the Stephenson link type, with double bar links. There are no independent cut-off valves, but provision is made to vary the cut-off in each cylinder from 5/10 to 7/10 of the stroke in the usual manner by means of a block moved by a hand screw geared in a slot in the end of the arm on the reversing shaft.

The main pistons are of cast steel, dished, and are fitted with two packing rings. The piston rods, con-

Each engine bed plate is made of cast iron, in one piece, and bolted to the condenser by the flanges at the ends of the six girders of the bed plate.

The reversing gear consists of a steam cylinder 9 inches in diameter and with an 11-inch stroke, with piston acting directly on an arm fixed on the reversing shaft. The valve of this engine is worked by a system of differential levers, the primary motion being derived from the hand lever at the working platform and the secondary motion from a point on the reversing arm. The turning gear consists of a worm wheel on the

main shaft, worked by a worm with a hand ratchet.

Each engine is fitted with a double poppet balance stop valve, 6 inches in diameter.

Following are some of the principal engine dimensions:

The cylinders are 17, 27 and 43 inches in diameter by 24 inches stroke. The valve stems are 2 1-4 inches diameter and the piston rods 3 1-2 inches diameter. The length from center of crosshead to under side of piston is 3 feet 9 3-8 inches. The connecting rods are 4 feet 8 inches center to center, 3 3-4 inches diameter at upper end and 4 3-4 inches at lower end. The crank pin bolts are 2 inches diameter. The crossheads are 13 1-2 inches long and have a go-ahead bearing surface 10 1-2 inches broad and a backing surface 8 3-4 inches wide.

The crank, thrust, stern tube and propeller shafting is solid, of high tensile forged steel. The crank shaft of each engine is in two pieces, the coupling being between the H. P. and I. P. cyclinders. The cranks are set at angles of 120 degrees with each other, and the sequence of cranks is H. P., I. P. and L. P.

The propeller shafts are covered with a composition casing, and there are two bearings in each stern tube, which is of cast iron.

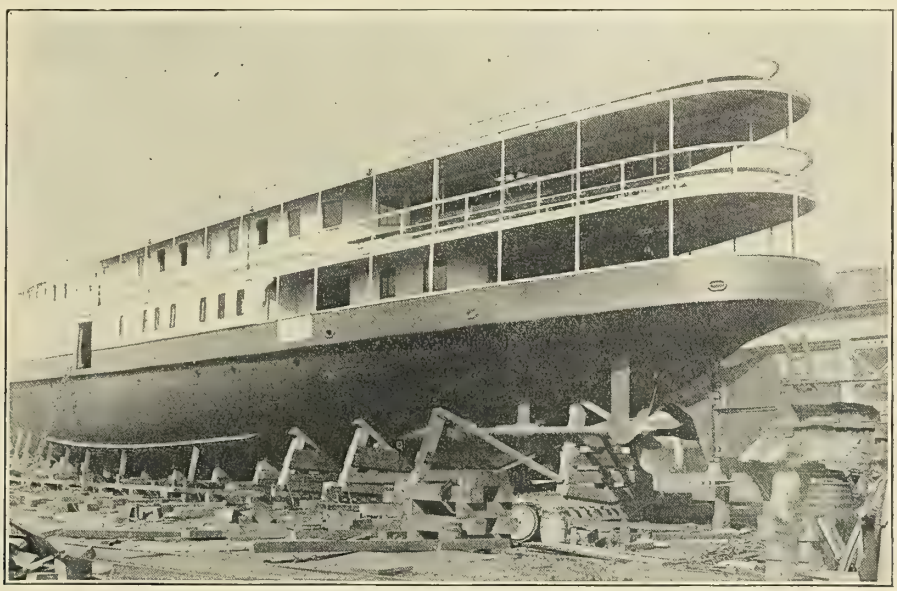
Each thrust bearing is of the horse-shoe type, secured firmly to the frames of the hull. The bearing faces are of white metal, channeled for the distribution of oil.

Following are the principal dimensions of this part of the machinery:

Crank shaft, diameter 8 inches.
Coupling disk, diameter 16 inches.
Coupling disk, thickness 2 1-2 inches.
Tapered bolts, mean diameter 2 inches.
Journals, diameter 8 inches.
Journals, length 8 1-4 inches.
Crank pins, diameter 8 inches.
Crank pins, length 9 inches.
Crank webs, width 9 inches.
Crank webs, thickness 4 3-4 inches.
Thrust shaft, diameter 8 inches.
Collars, number of, 8.
Collars, diameter 14 inches.
Collars, thickness 1 5-8 inches.
Collars, space between 3 1-4 inches.
Stern tube shaft, diameter 8 1-2 inches.
Propeller shaft, diameter 8 1-2 inches.

There are two main condensers, one for each engine. They are of cast iron and form a part of the framing and bed plate of the engine. Each condenser is cast in one piece of 1-inch metal. The water passes twice through it, once forward and once back. This water is furnished by an independent centrifugal pump, one to each condenser. Following are the principal dimensions:

Thickness of shell, 1 1-8 inches.



THE VIRGINIA READY FOR SIDE LAUNCHING FROM THE YARD OF WM. R. TRIGG CO.

Width, inside, 21 inches.
Height, over all, 4 ft. 11 inches.
Tubes, diameter 5-8 inch outside.
Length between tube sheets, 10 ft. 4 1-2 inches.
Thickness of tubes, 18 B. W. G.
Number of tubes to each condenser, 809.
Total cooling surface both condensers, 2,750 sq. ft.
Ratio of cooling surface to heating surface in boilers, 1 : 2.43.

There is one air pump for the two condensers with one 12-inch steam cylinder and two 20-inch buckets, with a stroke of 12 inches. The pump is arranged to draw from the condensers of both engines and discharge into one common hotwell. Steam is taken from the auxiliary steam pipe with a 1 1-2-inch pipe and the exhaust goes into either condenser, or atmosphere.

For each main condenser there is a centrifugal double-inlet circulating pump, which is arranged to draw from the sea and bilge. It is driven by an in-

dependent vertical, single cylinder engine. Following are the principal dimensions:

Steam cylinder, diameter 6 inches by 6-inch stroke.
Diameter, pump runner, 30 inches.
Width at periphery, 4 inches.
Diameter of inlet nozzle, 8 inches.
Diameter of outlet nozzle, 8 inches.

The screw propellers are two in number, of cast steel, of the modified Griffiths type, each with three blades. They are true screws, bent backward 6 inches at the periphery. The starboard, left hand. The port propeller, right hand. Each propeller is secured to its shaft by a single key and a composition nut, screwed on and locked in place. Following are the principal dimensions and data:

Number of blades, 3.
Diameter, 8 ft. 0 inches.
Length of hub, 18 3-4 inches.
Pitch, 11 ft. 9 inches.
Greatest width of blade, 32 3-4 inches.
Helicoidal area, 21 square feet.
Disk area, 50.26 square feet.
Pitch ÷ diameter, 1.47.
Helicoidal area ÷ disk area, .417.

BOILERS.

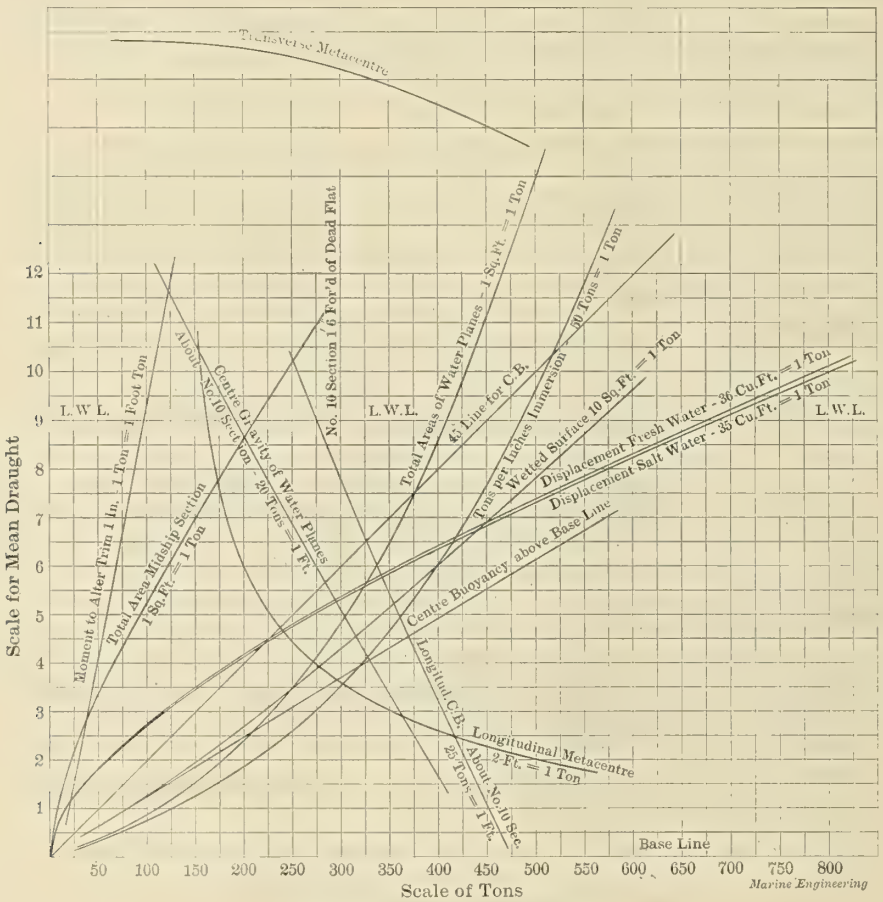
There are two Thornycroft boilers, of the improved Daring type.

In this type of boiler there is one steam drum, situated at the apex of a triangle, and three water drums, equidistant along the base line, one being at each corner and one in the middle. The steam drum is connected to the water drum by a number of curved tubes of small diameter, for the generation of steam. The steam drum is also connected to the center water drum by down take pipes for the water circulation. The back and front of the furnace are built up to the arch of the tubes with fire brick, and on each side to the joint of the tubes with the water drums. Each boiler is bolted to angle irons which are riveted to the saddles.

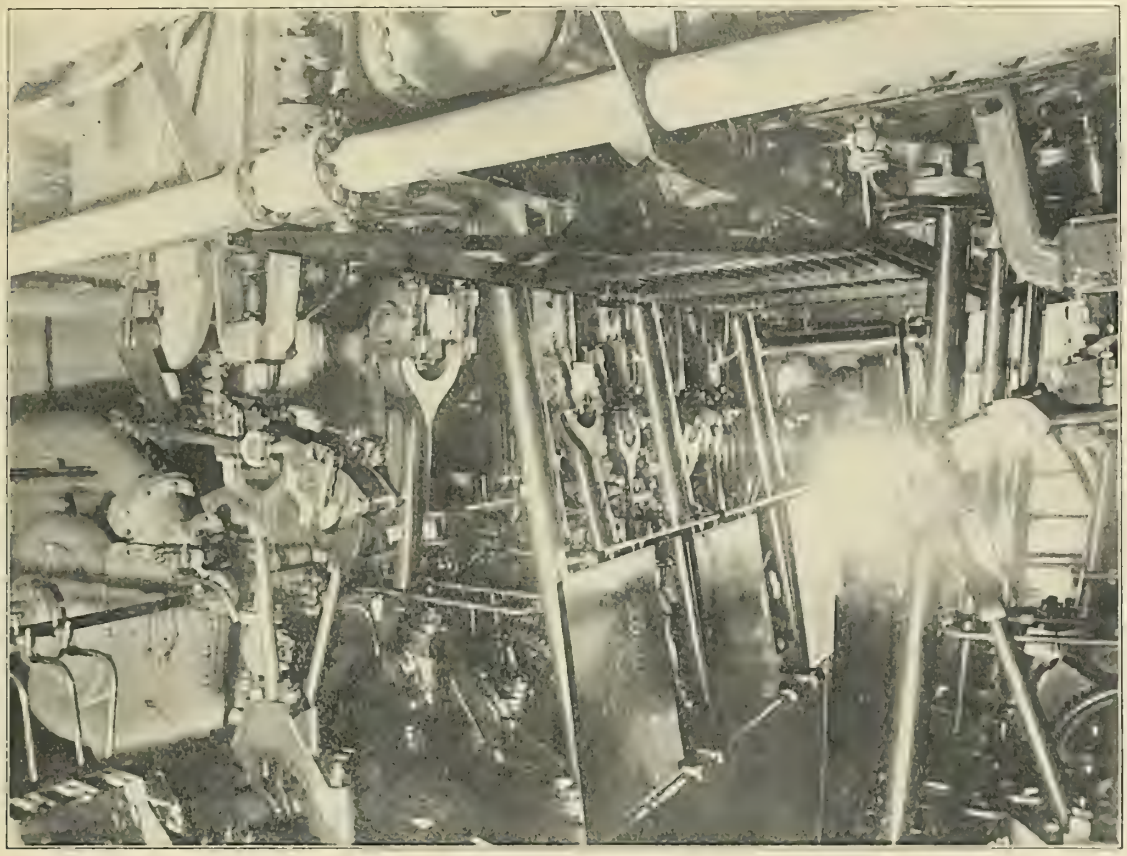
The boiler is covered with a casing consisting of 1-4-inch sheet asbestos, and outside of that a 1-inch sheet of non-conducting material, the whole protected by sections of light steel plates of such size as to be easily removable while the boiler is in place. There are two furnaces to each boiler, the shape of which is fixed by the arch of the tubes, and two doors to a furnace. The circulation of the water, generally speaking, is up the small curved tubes to the steam drum and then down the water tubes to the water drum. The boiler tubes are of solid drawn steel. The boilers are placed fore and aft, in one water-tight compartment abaft the engine, and there is one smoke stack for the two boilers.

Following are the principal boiler data:

Steam pressure at boilers, 200 pounds per square inch.


Transverse Metacentre
Scale for Mean Draught
Scale of Tons
L.W.L.
Base Line
Marine Engineering
Moment to Alter Trim 1 in. 1 Ton = 1 Foot Ton
Total Area Midship Section 1 Sq. Ft. = 1 Ton
About No. 10 Section
Centre Gravity of Water Planes
No. 10 Section 1 6 For'd of Dead Flat
Total Areas of Water Planes 1 Sq. Ft. = 1 Ton
45° Line for C.B.
Tons per Inches Immersion 10 Tons = 1 Ton
Wetted Surface 10 Sq. Ft. = 1 Ton
Displacement Fresh Water - 36 Cu. Ft. = 1 Ton
Displacement Salt Water - 35 Cu. Ft. = 1 Ton
Centre Buoyancy above Base Line
Longitud. C.B.
Longitudinal Metacentre
2 Ft. = 1 Ton
25 Tons = 1 Ft.
About No. 10 Sec.

CALCULATION CURVES FOR THE VIRGINIA.



VIEWS IN THE ENGINE AND BOILER ROOMS OF THE VIRGINIA.

Steam pressure at engines 200 pounds per square inch.
Number of boilers, 2.
Length of steam drum, 12 ft. 9 inches.
Width over casing, 11 ft. 0 inches.
Height over casing, 12 ft. 6 inches.
Steam drum diameter, inside, 37 inches.
Steam drum, thickness, 1 inch.
Furnaces, width of grate, two furnaces to each boiler, 6 ft. 9 inches.
Furnaces, length of grate, 7 ft. 0 inches.
Number of doors, 4 in each boiler.
Number of 1 1-8-inch tubes, 1,346 in each boiler.

Name—Virginia Nationality—American Type—Fast Propeller
Launched—1901 Builder—Wm. R. Trigg Co. Owner—C. & O. R. R. Co.

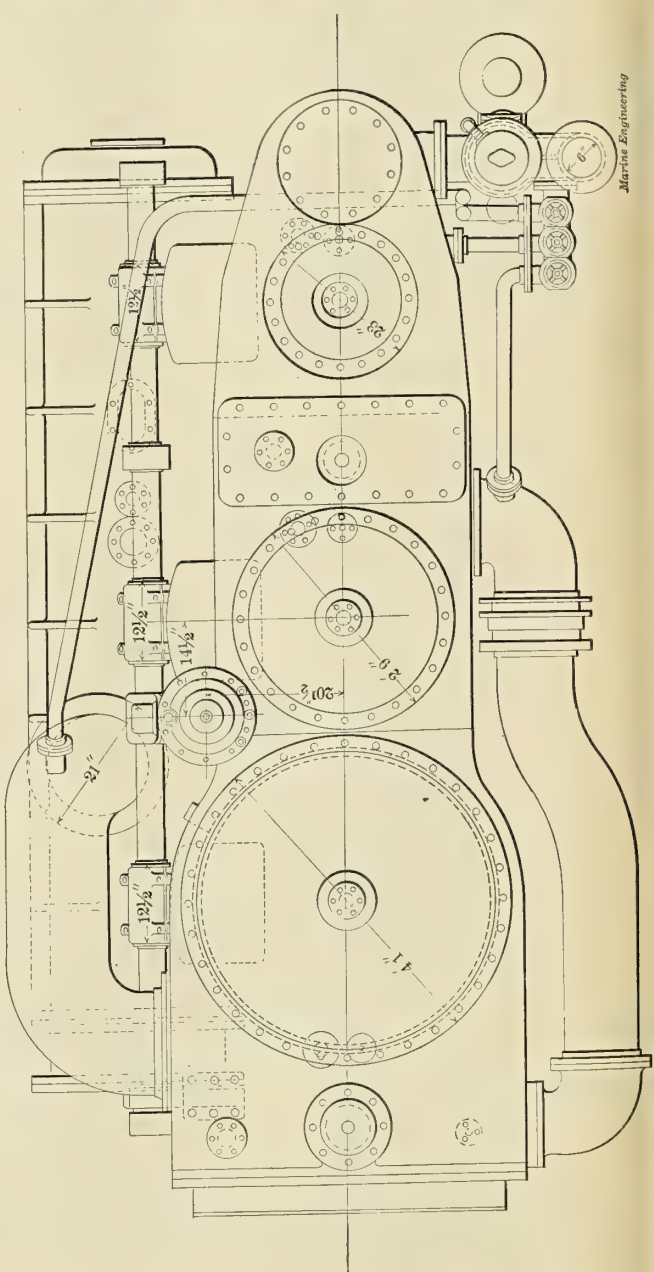
Length over all	200 ft.	Cylinders, diam	17, 27, 43 in.
Length between perpendiculars	192 ft.	Stroke	24 in.
Beam, extreme	33 ft. 5 in.	Designed R. P. M.	190
Beam, molded	32 ft.	" I. H. P.	2,500
Beam at load water line (9 ft.)	31 ft. 5 in.	" Speed (trial)	18¼ knots
Draft (sea-going condition)	9 ft.	Condens. Surf. (two condensers)	2,750 sq. ft.
Corresponding displacement including skin	693 tons	**Boilers,** number	2
Area immersed ⌖ to 9 ft. water line	213 sq. ft.	Type	Thornycroft Water Tube Daring
Tons per inch load water line	9.75	Steam pressure (at boilers and engines)	200 lbs.
Center of gravity of L.W.L. plane aft ⌖	5 ft.	Length of Steam Drum	12 ft. 9 in.
Center of buoyancy above top of keel	5 ft. 6½ in.	Inside Diam	37 in.
Center of buoyancy aft ⌖	1 ft	Width over casing	11 ft.
Number of frames	97	Height	12 ft. 6 in.
Coal bunker capacity	60 tons	Furnaces in each	2
Propellers, number of blades	3	G. S total	188 sq. ft.
Diameter	8 ft.	H. S. total	9118 sq. ft.
Pitch	11 ft. 9 in.	Draft	Closed fire-room system
Area	21 sq. ft.	H. S. ÷ G. S.	48.5
Engines, number of	2	H. S. ÷ I. H. P.	3.64
Type	3 cylinder triple	I. H. P. ÷ G. S.	13.3

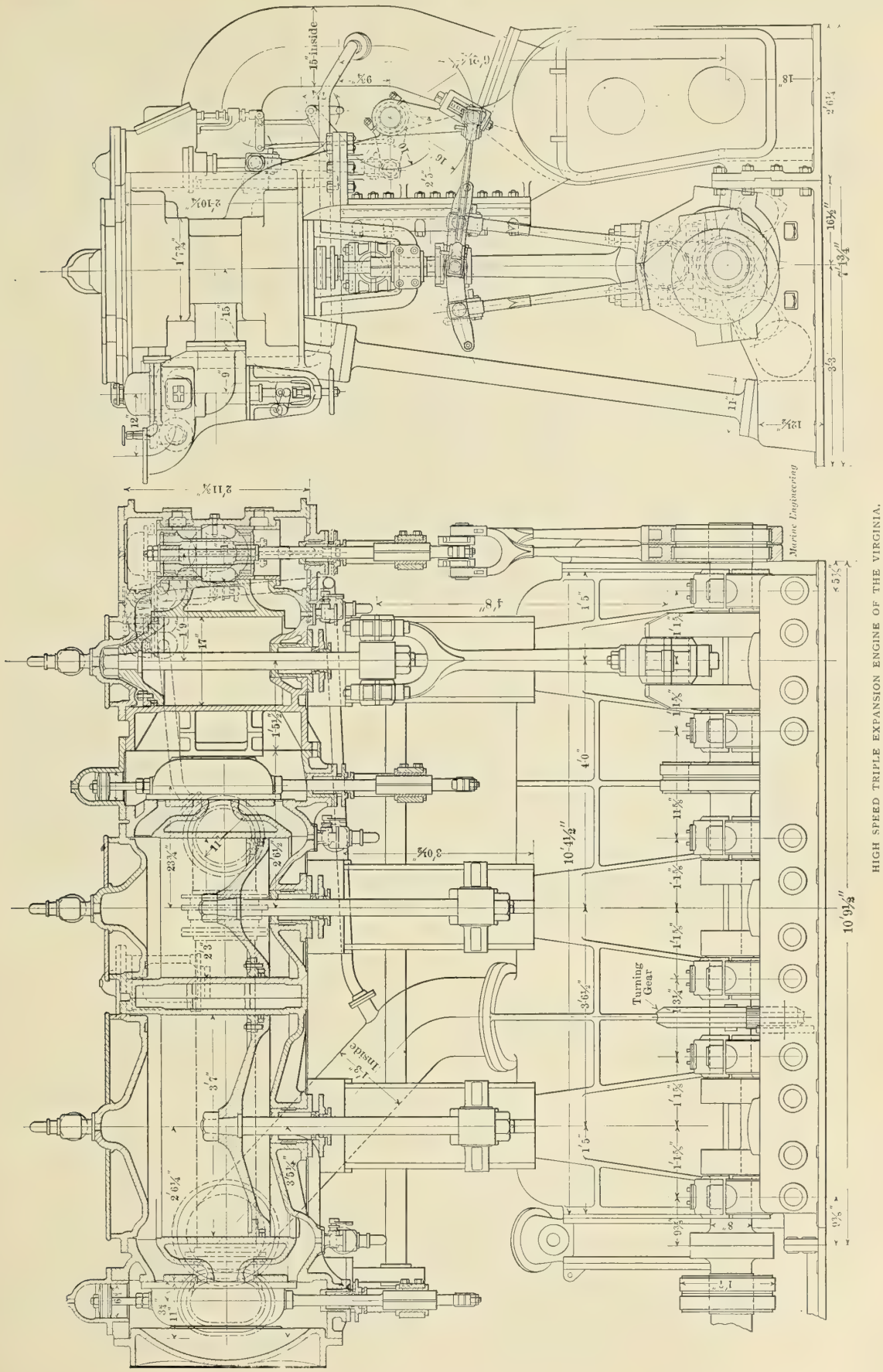
Number of 1 1-4-inch tubes, 372 in each boiler.
Thickness of tubes, 11 B. W. G.
Ratio heating surface to grate surface, 48.5 : 1.
Smoke pipe, oval section.
Smoke pipe, area 27 square feet.
Height above lower grate, 60 feet.
Safety valves, one on each boiler, 4 1-2 inches diameter.
Main stop valve, diameter 6 1-2 inches.
Total heating surface, two boilers, 9,118 square feet.
Total grate surface, two boilers, 188 square feet.
The closed fire room system of forced draft is used, the air being supplied by two blowers in the fire room. These were made by Mr. W. D. Forbes, and their performance was in every sense satisfactory. The fans are driven by simple enclosed engines, set horizontally. Following are the principal dimensions and data:

Fan, diameter ..... 54 inches
Width at rim ..... 14 inches
Diameter of induction nozzle ..... 36 inches
Revolutions to maintain air pressure of 1 1-2 inches .....800 per min.

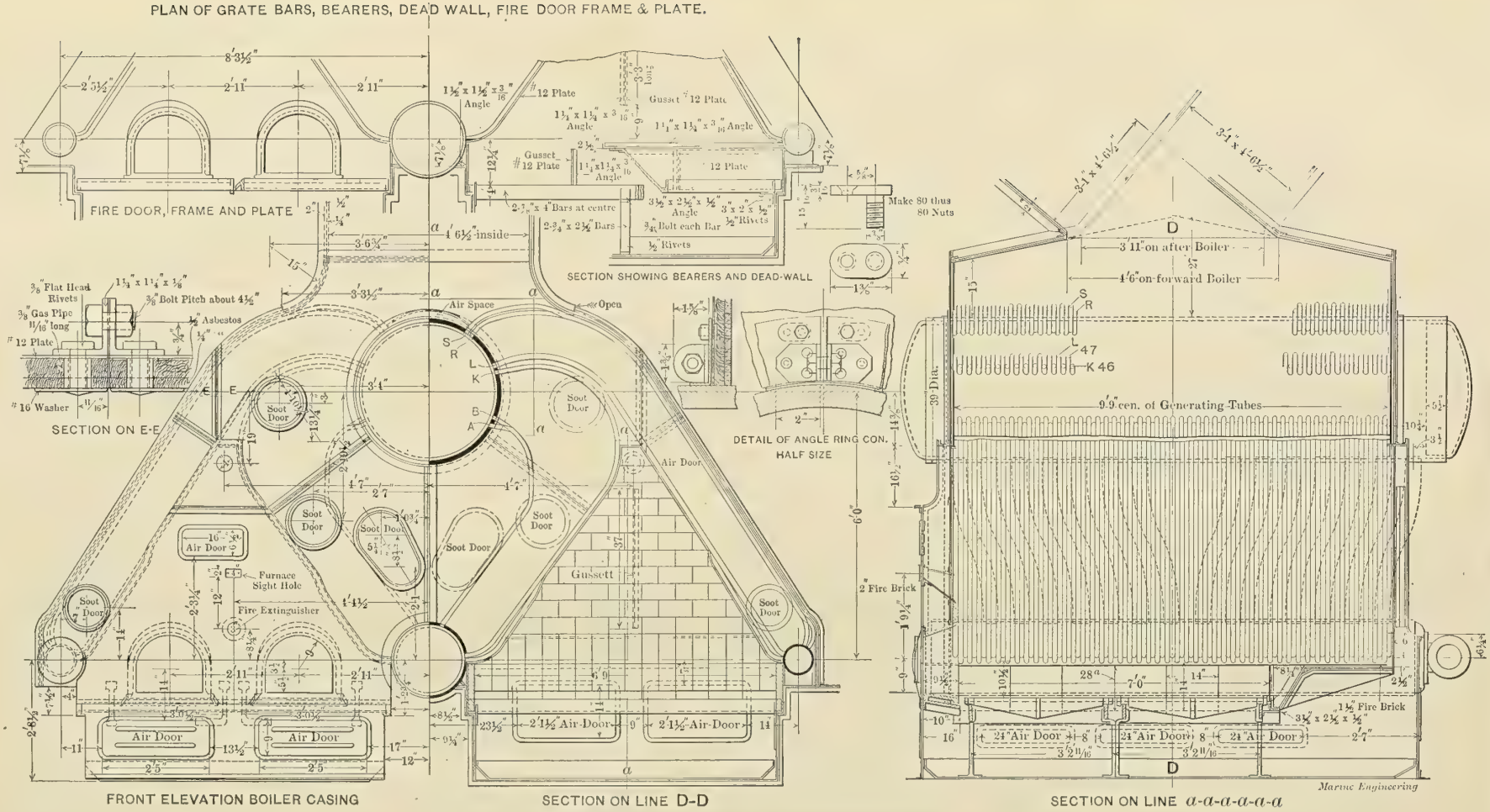
There is one main and one auxiliary Davidson feed pump, of the vertical, simplex, double-acting type. Both feed pumps are located in the engine room. The main feed pump draws from the feed tank and hotwell and delivers to the boilers. The auxiliary feed pump, which also acts as a fire pump, draws from the sea, bilge, feed tank, hotwell and ballast tank and delivers to boilers, overboard and to fire main.

There is one Davidson bilge pump, which draws





HIGH SPEED TRIPLE EXPANSION ENGINE OF THE VIRGINIA.


PLAN OF GRATE BARS, BEARERS, DEAD WALL, FIRE DOOR FRAME & PLATE.
FIRE DOOR, FRAME AND PLATE
SECTION SHOWING BEARERS AND DEAD-WALL
SECTION ON E-E
DETAIL OF ANGLE RING CON. HALF SIZE
FRONT ELEVATION BOILER CASING
SECTION ON LINE D-D
SECTION ON LINE a-a-a-a-a-a
Marine Engineering

THORNYCROFT WATER TUBE BOILER ON THE VIRGINIA.

from the bilge and ballast tank and delivers to fire main and overboard.

There is one Davidson sanitary pump, which draws from the sea and discharges to water-service and sanitary system. In addition there is one fresh water pump for wash purposes only.

There is one feed tank for the two engines, a part of the tank being fitted as a filter, into which the water flows from the air pump. The tank and filter have the following connections: Discharge pipe from feed pump, overflow pipe to bilge, suction to feed pump, vapor pipe and drains from traps. All places where

condensed steam can accumulate are fitted with drain pipes and traps, with discharge into feed pipes. The traps are provided with by-pass pipes and valves for convenience in overhauling the steering engine.

The chief deck auxiliaries are a steam windlass, Hyde hand capstan, with horizontal wild cat for 1-inch chain, and a Williamson steam steering gear, with double 5 by 5 1-2-inch engine.

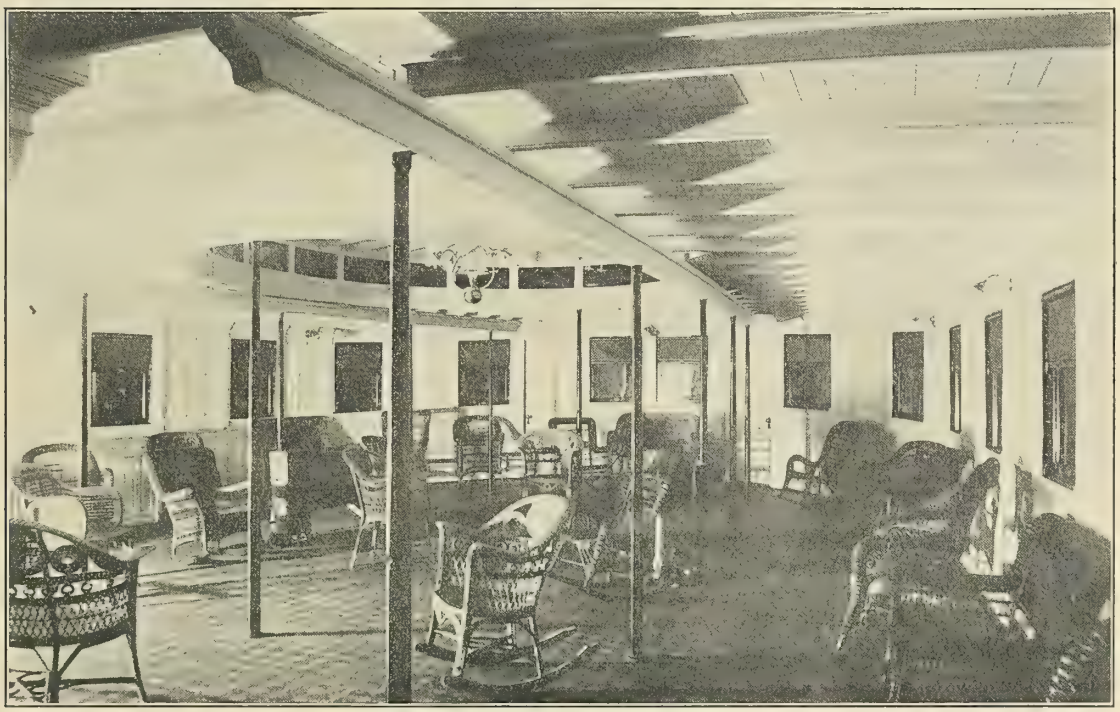
ELECTRIC LIGHT PLANT.

The electric light installation consists of 180 16-C. P. 110 volt lamps, which are supplied by a 10 K. W. direct-connected generating set of the General Electric make, which is located on the port side aft of the port engine. The generator leads are encased in iron conduit and lead direct to the main generator switch on the switchboard.

tight and decorative fixtures. The plant was thoroughly tested after the complete installation, and proved to be satisfactory in every respect.

The trial of the *Virginia* took place at the mouth of Chesapeake Bay on February 5, 1902. The trial was conducted by the William R. Trigg Company, who were represented by Mr. J. A. Nelson, general superintendent, and Mr. Thomas Jardine, superintendent of machinery. The Chesapeake and Ohio Railroad was represented by Captain Cooksey, superintendent of floating property, and Captain Warren, now captain of the *Virginia*. The weather was favorable and sea smooth. After a four-hour trial at full speed the boat was run over a measured course and maintained a speed of 18 1-2 knots, against a heavy tide.

The forced draft pressure was about two inches. The

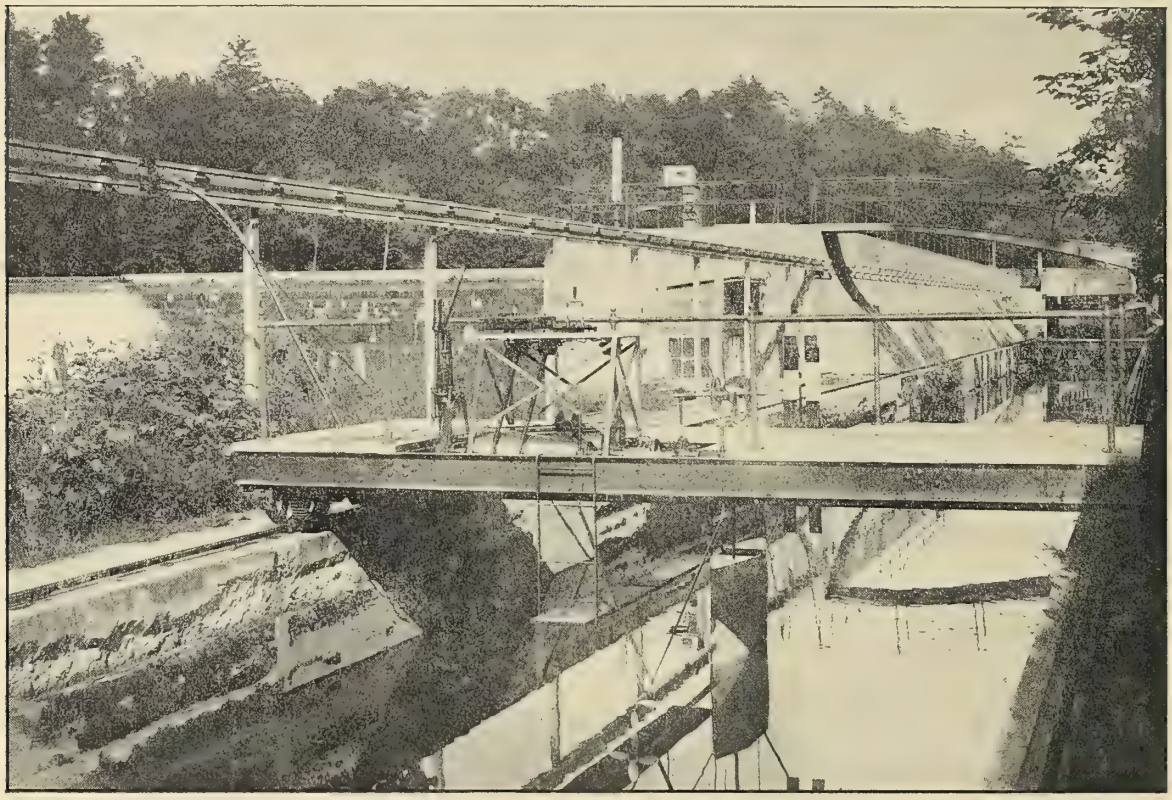


MAIN SALOON ON THE STEAMER VIRGINIA.

The switchboard is mounted on the bulkhead between the engine room and shaft alleys, supported by suitable iron brackets. The switchboard is made of 1 1-4-inch black enameled Vermont slate, and has mounted on it the necessary volt- and ammeters, generator and circuit switches, together with the pilot lamp fixtures and ground detector lamps. All wiring in the engine and fire rooms is encased in iron conduit, with water-tight junction boxes, and water-tight fixtures are used in connection with the lamps. A small panel board with several switches is mounted in the engine room, from which the various circuits feeding the engine and fire rooms are controlled. The main feeders from the switchboard to the various panel boards on the main, saloon and hurricane decks are also encased in iron conduit, which passes up through the engine enclosure. The wiring on the main, saloon and hurricane decks is in standard molding, and leads to the various water-

boilers steamed freely and steadily, the engines worked smoothly and all auxiliaries gave entire satisfaction. The trip was a success in every particular, and the company are to be congratulated on the sucess of their first merchant boat.

Steamship Thespis.—On December 23d the new steamship, *Thespis*, built by Sir Raylton Dixon and Company, Ltd., Middlesboro, England, to the order of Messrs. Lamport and Holt, made her official trial, and was accepted by the owners. The principal dimensions are: 390 feet length between perpendiculars, 50 feet breadth, by 29.6 feet molded depth, dead weight carrying capacity, 6,450 tons. She is built for the trade between Brazil, New York and Liverpool, and has handsome passenger accommodations for a limited number on the bridge deck amidships.



THE CORNELL UNIVERSITY EXPERIMENTAL CANAL.

EQUIPMENT FOR EXPERIMENTAL WORK ON RESISTANCE AND PROPULSION OF SHIPS INSTALLED AT THE HYDRAULIC LABORATORY OF CORNELL UNIVERSITY.

BY W. F. DURAND.

The new hydraulic laboratory of Cornell University installed in charge of the College of Civil Engineering possesses among other features a canal or tank about 340 feet in length by 16 feet wide and 10 feet deep. It is in part excavated through the shaly rock which prevails in the locality, and in part formed by walls of a special mixture of concrete. The surfaces of the canal wall are all faced with a layer of silica-cement from two to three inches in thickness.

The canal is provided with water from the reservoir above, through double shut off gates and an intermediate lock or measuring chamber. Once filled the water is quiescent and the level may be maintained where desired by an adjustable weir at the western end.

At the present time the canal is open to the weather. It is to be hoped that in the near future means may be found for covering it over and thus greatly extending the facilities for work. Through the courtesy of the College of Civil Engineering the facilities provided by this canal are open for the use of the School of Marine Construction for experimental research along lines of importance to this field of engineering work. The two chief lines of work which can be carried on in such a canal and which are of value to the science and art of marine construction are those relating to the resistance of ships and to their propulsion. The equipment thus far installed consists of the following leading features:

(1) A carriage or truck spanning the canal and carrying the propellers to be tested and the apparatus required, and running on a track extending the length of the canal.

(2) A transmission dynamometer for the measurement of the power absorbed by the propeller.

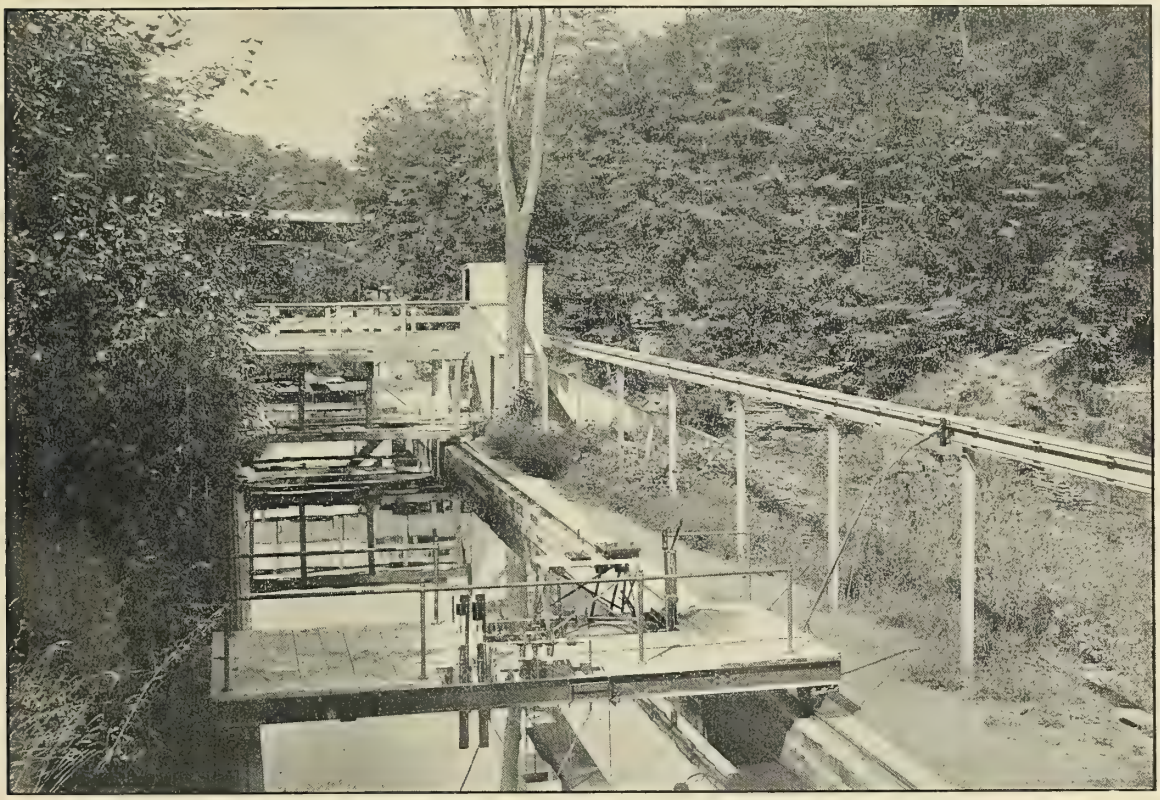
(3) Means for driving the propeller through the dynamometer at speeds varying through a wide range, and for any run in constant proportion to the speed of the truck along the rails.

(4) A thrust dynamometer for measuring the thrust developed.

(5) Means for registering time, distance, and revolutions.

CARRIAGE OR TRUCK.

This consists essentially of a platform about 8 by 18 feet, and carried primarily on two 10-inch steel channels spanning the canal, with two shorter I beams framed in between at each end, as shown on the general arrangement plans of Fig. 1. Between the latter are carried the wheels and motive power. The latter consists of one 15 H. P. electric motor geared down by a double reduction to the driving axle. The range of speeds at present contemplated is from about 100 to 800 feet per minute, or from about 1 to 8 knots. The speed of the motor is under control by means of a rheostat at the starting end and in circuit with the field coils of the generator in the power house. By means of this setting rheostat an adjustable E. M. F. can be readily provided



THE EXPERIMENTAL CANAL, LOOKING WEST.

at the motor, and thus any speed obtained within the limits provided.

For the more common range of speeds, 300 to 500 feet per minute, the distance required for acceleration is found not to exceed thirty to fifty feet.

TRANSMISSION DYNAMOMETER.

The form adopted is that used in the experiments previously made on Cayuga Lake and elsewhere described.* This consists of a special form of rope dynamometer as shown in Fig. 2. The rope leads around the driving sheave on the after end of the propeller shaft, the two parts passing over sheaves *H* and *I*, and then around the driving sheave *G*. These sheaves are all of the same diameter, in the present case 10 inches. The sheaves *H* and *I* are mounted with ball bearings on a shaft *PQ* which is carried by a block *LM*, the latter being connected to the base by a pair of thin plates of spring steel. This is the well known Emery support or substitute for a knife edge, and for slight movements is almost perfectly frictionless, at the same time affording rigidity in the directions desired. The sheaves *H* and *I* and their shaft thus form a balanced rocking system or lever pivoted in the middle and therefore without deflection so long as the tension of the rope on the two sides is the same. When running, however, the difference between the tensions on the tight and loose sides determines a moment which tends to throw this arm down. The downward thrust is then measured either by a spring dynamometer, or by specially designed hydraulic step connected to a mercury manometer.

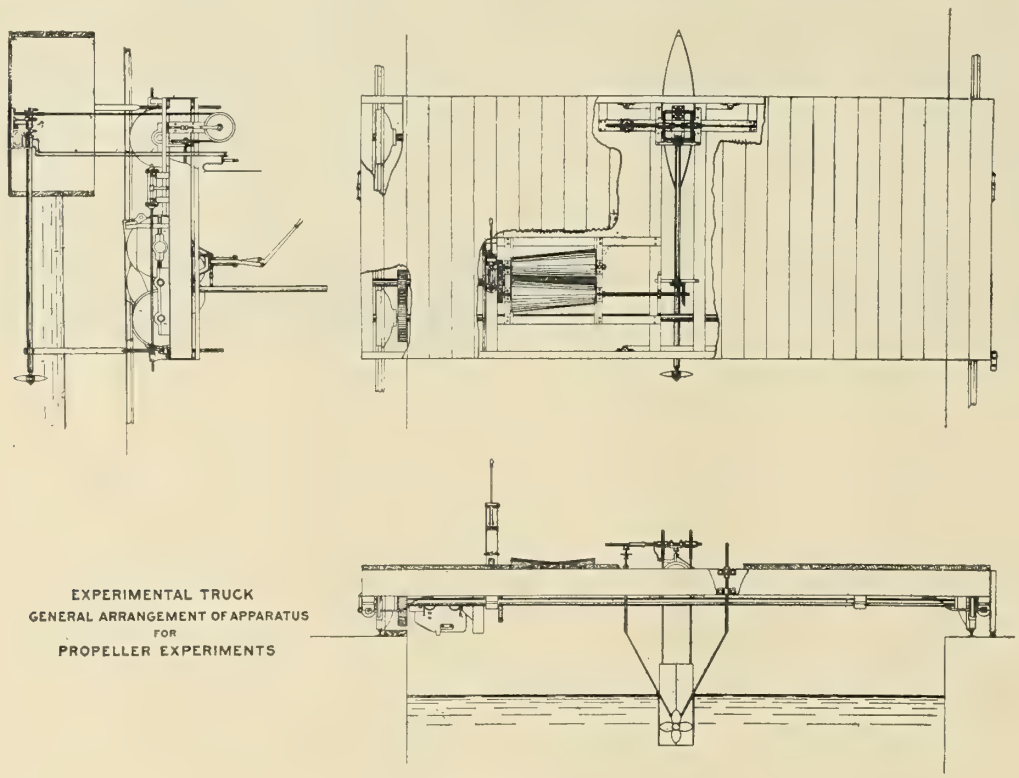
A is a cylinder with plunger fitted with extra care so as to work with small leakage of oil and almost perfect absence of metallic contact. The head of the plunger rod is spherical and is connected to the rocking shaft through the socket *B* which provides a ball-bearing rest for the spherical head and thus entire absence of angular constraint between the two. The base of the cylinder *A* is also carried on a flexible support so that any slight angular movement which may be given to it as a result of the up and down motion of *B* will be free from all constraint. The downward thrust of the shaft *PQ* is thus transmitted to the plunger and thence to the oil in the lower part of the cylinder the pressure of which is read or registered by an ordinary open mercury manometer. The movement of the shaft *PQ* is limited by stops to about ¼ inch on either side of the position of equilibrium. A hand pump is connected up for supplying oil to the cylinder, and this together with an overflow make it an easy matter to keep the shaft floating between the stops during the runs. In order to remove any residual frictional resistance to the longitudinal movement of the plunger in the cylinder, the plunger rod is provided with a means for rotating it on its axis either by hand when reading, or automatically, such motion being allowed by the spherical joint at the top of the rod as referred to above. By this means a very delicate measure of the forces is obtained, the reading being the height of the mercury column which may reach values of 12 to 15 inches or more. The location of

* Proceedings Society of Naval Architects and Marine Engineers, Vol. V, page 107.

the arrangement relative to the shaft *PQ* is adjustable so that the capacity of the dynamometer may be increased with the same range of reading by lengthening the effective arm of the plunger about the axis of the rocking couple.

The indications of the dynamometer are connected with the actual forces through a calibration by means of a prony brake placed on the propeller shaft in lieu of the propeller. For this purpose the water in the canal is drawn down leaving the brake out of water, and thus convenient for manipulation. All friction of the bearings in the dynamometers, small as it may be, is thus eliminated, and experience with this form of dynamometer shows that the indications are very delicate and accurate and the calibration constant.

HI engaging with those on the plunger rod. The connection between these pairs of arms is by means of a pair of small steel rollers carried by the arms *HI* and resting on *EF*. These rollers are carried also in ball bearings and the rollers are so adjusted that forward and backward motion of the plunger and rod is allowed by the rolling of the surfaces of one pair of arms on the rollers carried on the other pair. The torque is thus transmitted from the driving pulley to the plunger rod, with perfect freedom for the latter to move longitudinally back and forth. These various parts are carried in a small caisson or boat pointed fore and aft and hung from the truck by adjusting bolts, as shown in Fig. 1. The shaft, which is about 8 feet in length, is carried in a pipe to the forward support shown in the side elevation of Fig. 1. Here the pipe carries a ball bearing on which the shaft rotates and moves longitudinally as may be required. The other bearings are distributed as shown and the cylinder *A* Fig. 3 is simply supported between the two vertical faces of the base plate.



EXPERIMENTAL TRUCK
GENERAL ARRANGEMENT OF APPARATUS
FOR
PROPELLER EXPERIMENTS

FIG. 1.

VARIABLE SPEED CONTROL.

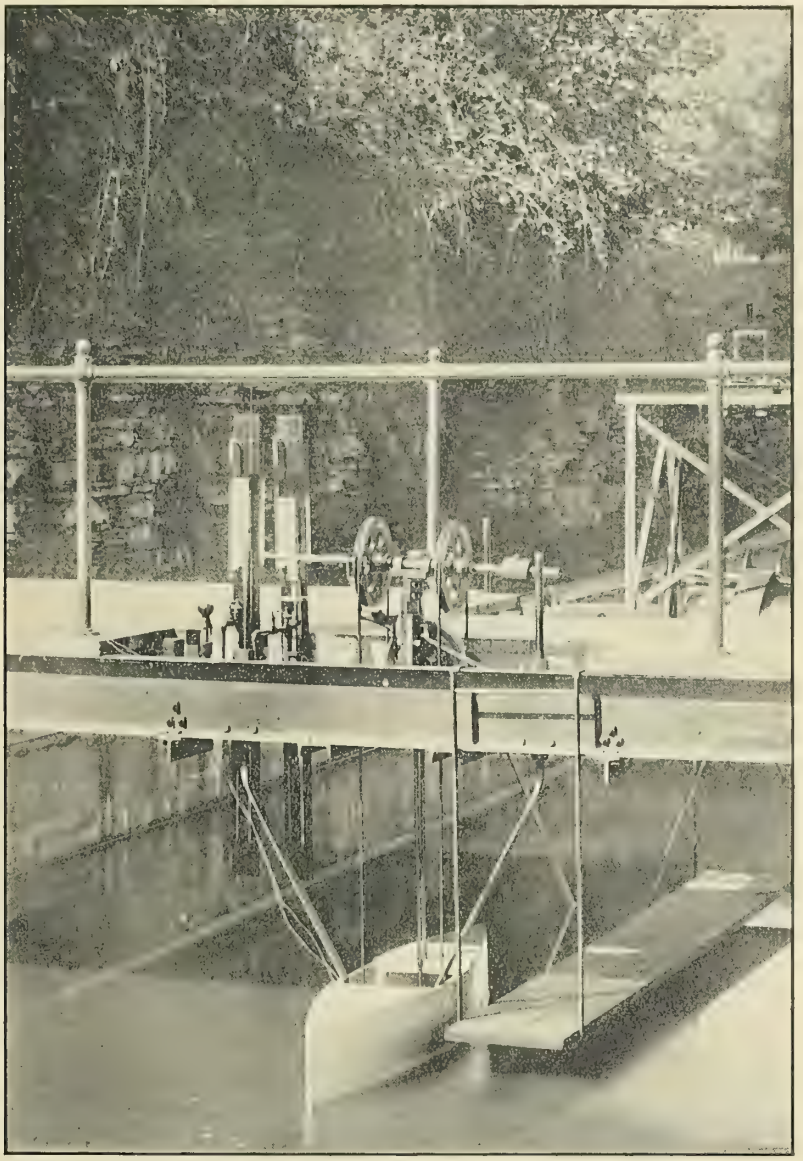
This is effected by driving the propellers through the transmission dynamometer by a shaft connected through an Evans friction cone and appropriate gearing to the motor. The general arrangement of these features is shown in Fig. 1. By means of a single change of gears and the friction cone, a range of revolution from about 120 to 700 at a speed of about 300 feet per minute is thus provided for.

THRUST DYNAMOMETER.

The thrust dynamometer is shown in Fig. 3 and consists of a cylinder *A* with plunger *B* to the rod of which is coupled the propeller shaft *C*. The plunger rod is also continued backward as shown at *D*, and carries a pair of driving arms *EF*. The driving pulley *G* is carried on a shaft running in ball bearings as shown. The forward part of the shaft carries a second pair of arms

The plunger and rod with propeller shaft attached is thus free to move back and forth without constraint from its surroundings. In operation the propeller is run at a number of revolutions relative to the speed of advance which will give it a positive slip, and thus a pull forward. The cylinder forward of the plunger is filled with oil connected to an open mercury manometer, and the forward pull developed by the propeller is thus opposed by the pressure of the oil, and the manometer becomes thus a means for measuring the force as desired. The space behind the plunger is also filled with oil under pressure from a stand pipe with a small res-

ervoir on the upper end, and at the height of the manometer. This balances the column of oil in the pipe between the manometer and the cylinder and leaves the mercury in the former free to record simply the forces developed by the propeller. A small hand pump is provided for forcing oil in forward of the plunger, as well as an overflow for allowing it to escape, so that between the two the location of the plunger may be adjusted as desired, and leakage of oil may be made up as necessary. The motion of rotation eliminates practically all frictional resistance to the longitudinal motion of the shaft, so that all of the pull developed by the propeller is transmitted to the oil, and the apparatus as a whole is found to provide an extraordinarily delicate and accurate measure of the forces involved.



THE CAR AND FLOAT.

The indications of the dynamometer are connected with the actual forces through a calibration effected by the use of a bent lever fitted with a knife-edge bearing, one arm of the lever being horizontal and the other vertical. To the former are hung known weights, while the end of the latter presses against the plunger shaft through an intermediate steel rod passed through a hole in the shaft of the driving wheel *G*. The shaft being then rotated, known weights are placed on the horizontal arm, thus producing known pressures axially on the plunger shaft. These pressures are measured by the manometer in the usual manner, and in this way its indications are connected with the actual forces in play.

The automatic registration of the forces in both the power and thrust dynamometers is made by means of a special type of open end mercury manometer as already referred to above. The indications of the mercury column are registered by the use of an aluminum float carrying a slender steel rod moving in guides, and to which is attached a light pen carriage and pen. The latter is held by a very light spring against the paper,

and the whole is free to rise and fall in answer to the movement of the column of mercury. In practice it is found that this form of recording device is reliable and sensitive, and that it can be depended upon to respond with certainty to the movements of the mercury column. The vertical drum carrying the paper is given motion from the driving axle so reduced as to revolve once for a complete run over the course. The indications of the manometers are thus recorded on a distance abscissa and show the history of the variation of the forces throughout the entire course of the run.

RECORDS OF TIME, DISTANCE AND REVOLUTIONS.

These records are all made by a chronograph of special form and recorded on a strip of moving paper. The time signals are furnished by a clock with electric seconds break attachment. The distance marks are given by an electric contact arrangement along the rails, and the revolutions by an electric contact attachment counting every fifth revolution of the propeller shaft.

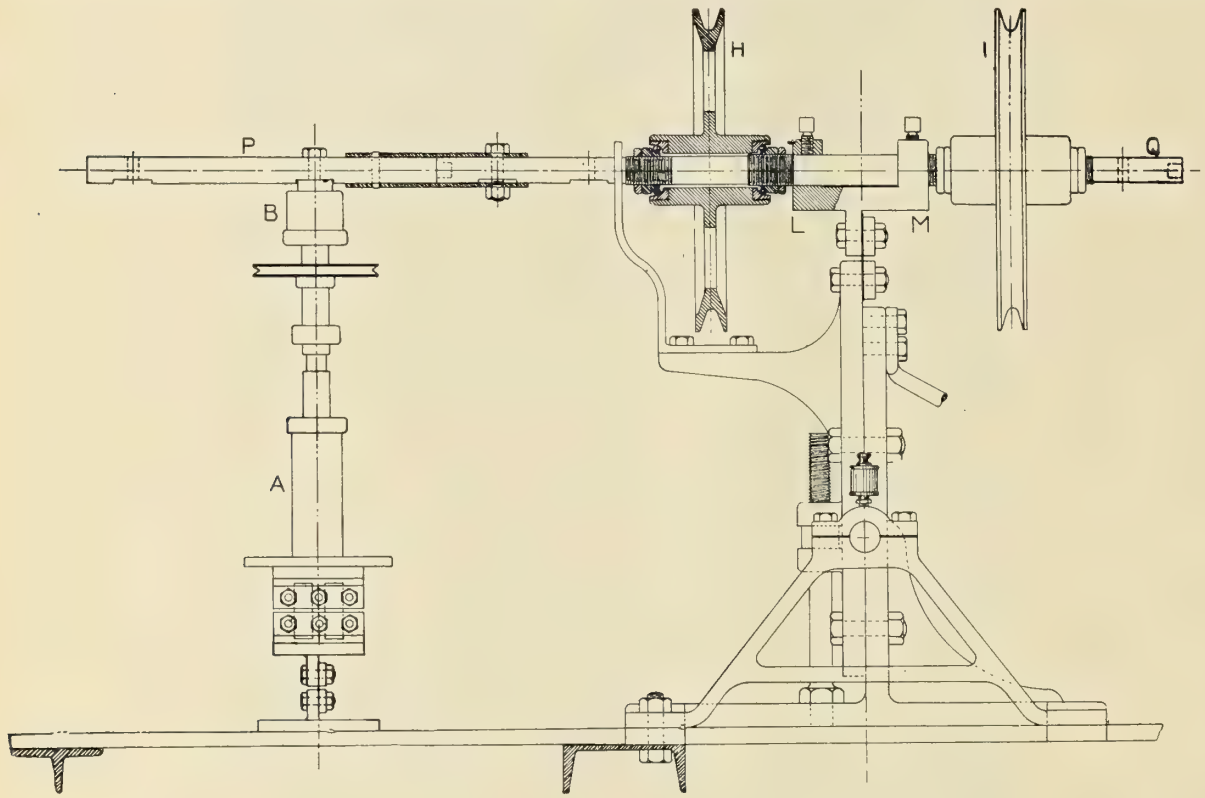


FIG. 2.

SPECIAL PURPOSE OF THE EQUIPMENT.

Problems arise in all branches of engineering work which cannot be properly investigated without the aid of experimental investigation. Nowhere is this more fully realized than in the field which is concerned with the design of ships and their propelling machinery, and with all the problems met with in this field, none is of higher importance or more completely dependent upon experimental investigation than those which arise in connection with questions of resistance and propulsion. It is indeed a fact that notwithstanding the enormous advances made by the science of mathematics, it is still entirely unable to deal with the problem of the forces concerned in the motion of a body through a liquid. These forces depend on so many variable conditions, and are related to these conditions in such obscure ways, that at present all attempts at a full mathematical discussion of the problem seems out of the question. The only method is, therefore, to investigate the problem experimentally in such way as shall best answer the needs of the case in hand.

In a general way such investigation might be of two kinds—direct or indirect. In the first the objects to be investigated are represented full size, and all the conditions of the problem are reproduced as nearly as may be, and the results noted. Thus we might determine the resistance of a torpedo boat by building the boat full size and then towing it at varying speeds and noting the resistance with a traction dynamometer. Or again the performance of a screw propeller might be examined experimentally by building the propeller full size, producing the conditions of use, and noting the forces developed. From the labor and expense connected with experiments on such a scale it is but rarely that they can be carried on in this manner, and if there were no other way, the application of experimental methods would be of limited use.

In fact the important feature in all experimental work of the kind we are now considering lies in the fact that the data for any one case may by appropriate laws be applied to an indefinite number of other cases, and thus its value as an observation indefinitely extended. The laws which govern this relationship being accepted as a

working basis, it becomes possible to represent the object under investigation by a comparatively small model. The latter is then made the subject of a direct examination under suitably related conditions, and the results thus found may then by means of the laws of comparison be used to determine the results for the full-sized body used under the conditions proposed. But this does not necessarily end the usefulness of the results thus found. Having served its immediate purpose it may be filed away for future use and may then be made to serve, as occasion arises, for an indefinite series of other similar problems under suitably related conditions. We shall not here enter into these laws of relation and comparison. It will be sufficient to note simply that their object is to render as far as possible the investigation independent of size or dimension, so that the series of cases referred to above may consist of an indefinite series of sizes, all of the same form and proportions, and operated under speeds related to that of the original model. With this by way of general introduction we may note briefly some of the important problems which such an equipment is able to aid in solving:

What size and form of propeller is suited to a given ship at a given speed?

What revolutions and speed might be expected of a given propeller fitted to propel a given ship?

How much surface can be given to a proposed propeller under stated conditions?

What is the relative efficiency of a propeller backing and going ahead?

What is the best combination of propellers as regards pitch ratio and distance apart, in the case of more than one propeller on the same shaft?

What is the least diameter of propeller that can be safely depended on to efficiently absorb a given amount of power under stated conditions?

What will be the effect in any given case of keeping steam pressure the same and slightly changing the pitch of the blades? etc., etc.

With slight additions to the equipment described above it will be possible to extend the range of investigation to cover the resistance of ship models and to aid in answering such questions as the following:

What is the resistance of a proposed ship at a given speed, and how much power will be required to drive her at such speed?

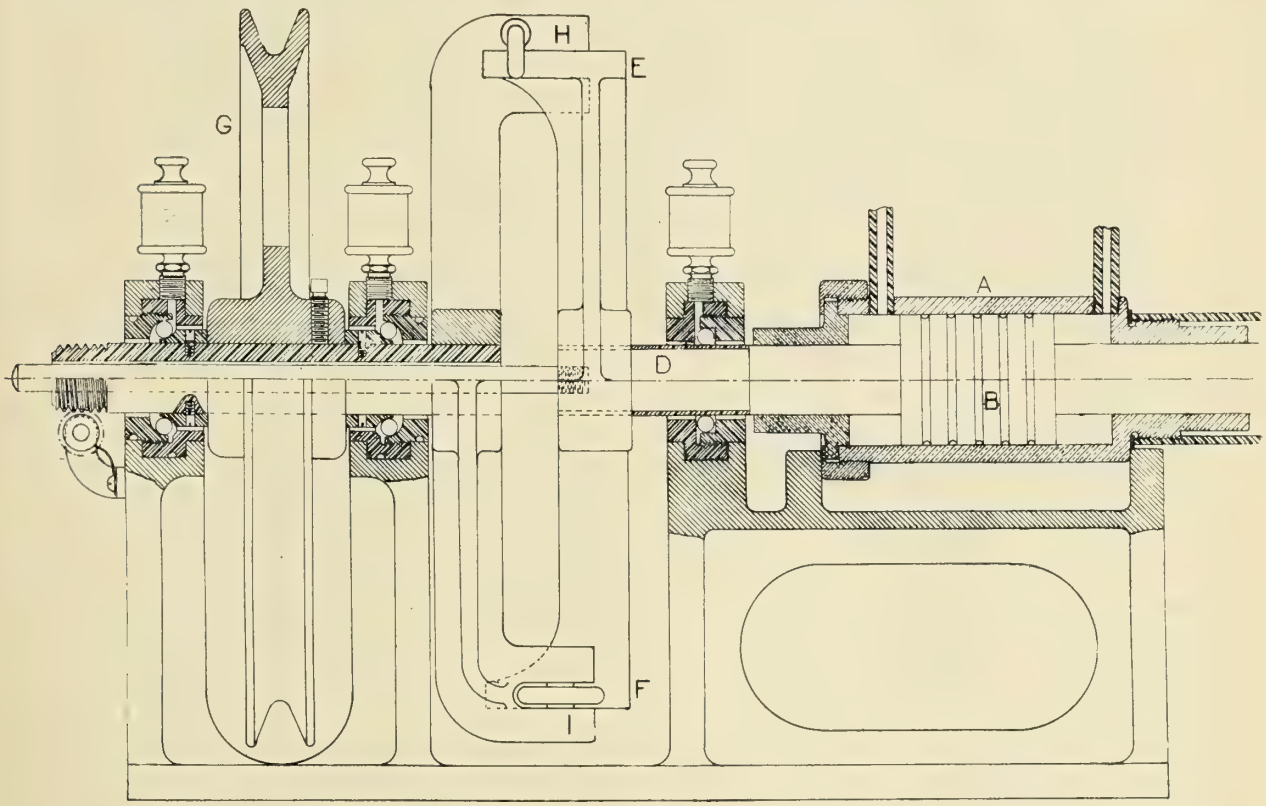


FIG. 3.

Which of two or more models proposed will require the least power at a given speed?

What type of propeller is best suited to a given or proposed model of ship?

What effect on the resistance of the ship will be produced by changing the location of the propeller nearer or farther from the stern post?

What effect will shallow water have on the power required to maintain any proposed speed with a given model? etc., etc.

The lines of experimental research which we have thus far noted are those directly connected with commercial questions. There is in addition a large field of work of the very highest importance and which has been but imperfectly worked over. This consists of the more fundamental problems connected with the forces acting

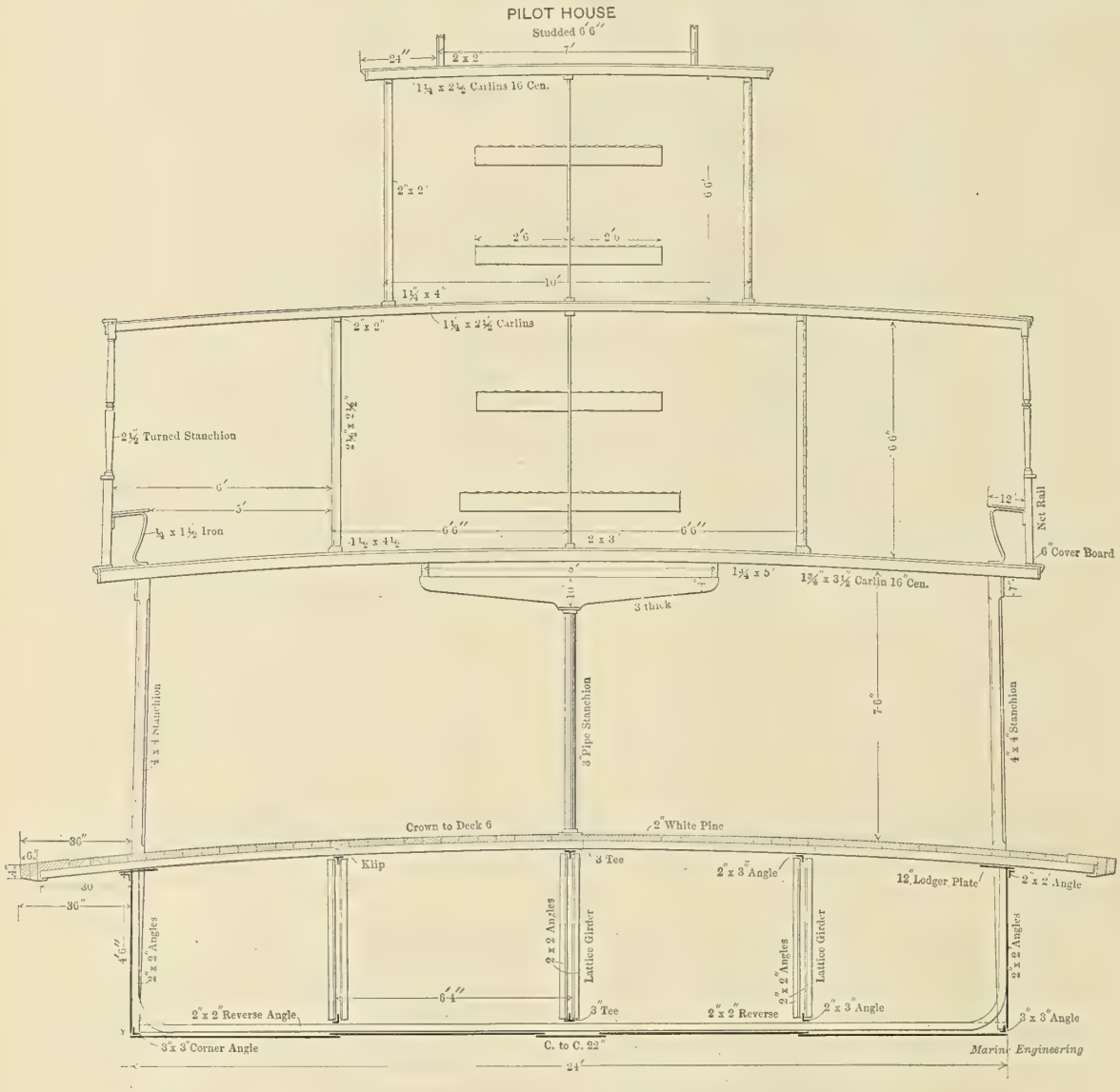
on bodies of elementary forms under varying conditions, such, for example, as planes of varying size and form moved at varying speeds, immersions, and angles of obliquity with the course. Likewise bodies of elementary form, such as the section of a propeller blade moved under varying conditions. There is in these and allied problems a vast field of work not related to any one commercial problem, but related to them all and to the whole subject in a very important and fundamental way. From the scientific standpoint, therefore, no work is at present more needed than a thorough and comprehensive examination of many of these questions, and no great advance in our theories of hydrodynamics as applied to such problems is likely to be made until the results of such investigations become available.

The programme of possible and really important work of this character which may and which should be done is so large that there will be no trouble in utilizing all the time and capital which can be found for the prosecution of these and allied lines of work.

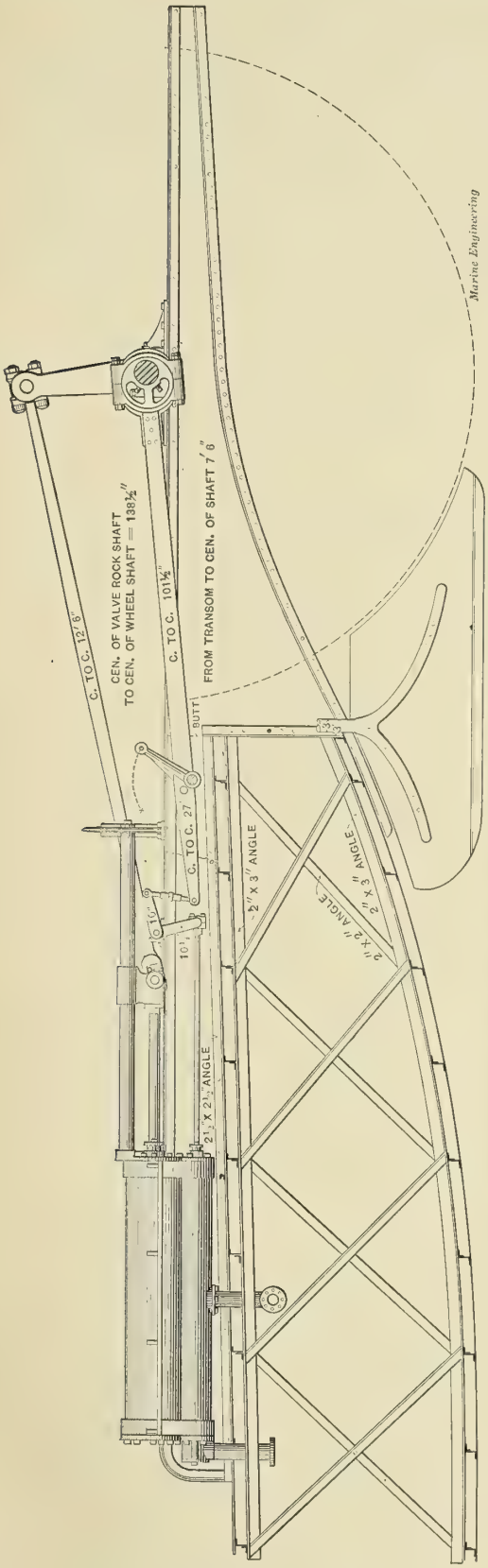
Stern Wheel River Steamer.

The fine steel stern wheel river steamer, the *City of Fayetteville*, has recently been completed by the Merrill-Stevens Engineering Company, Jacksonville, Fla., for service on the Cape Fear River of North Carolina. In the construction of this boat many novel ideas have been used, and she represents the latest type of shallow draft river steamer.

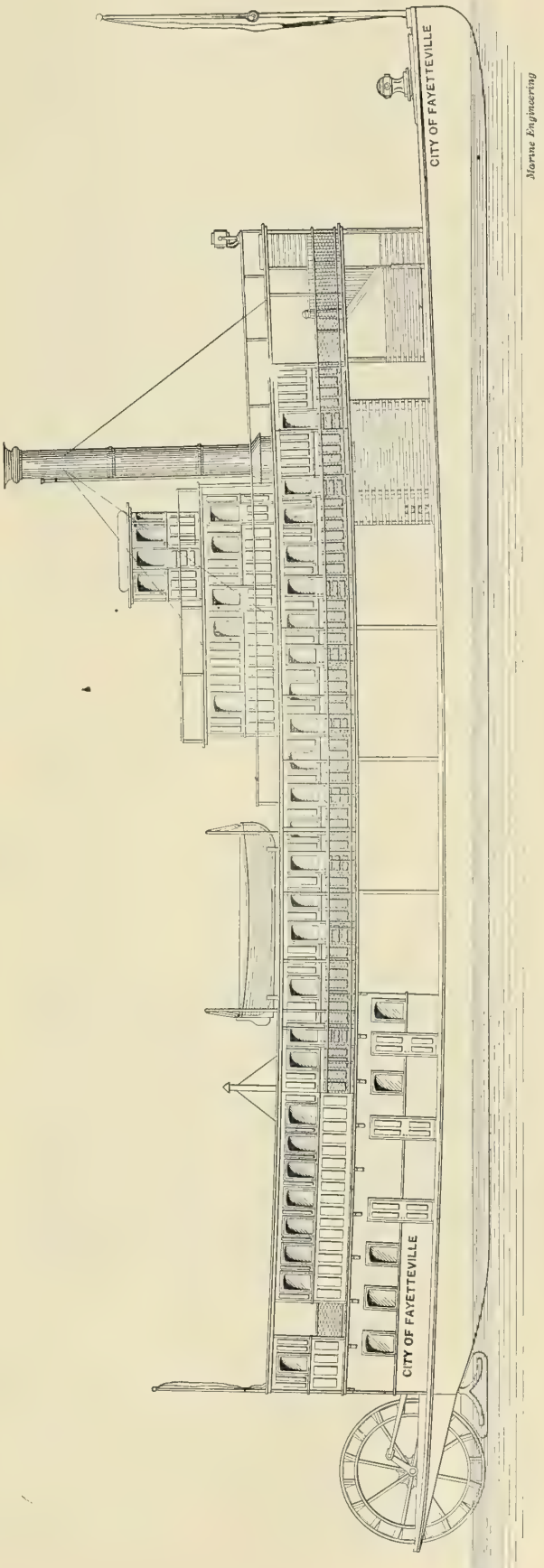
The hull is 125 feet long, and, including the transom at the stern, is 140 feet over all, the molded beam is 24 feet, the beam over all 30 feet, and the depth is 4 feet. The general construction is shown in the midship section and other views. To make the shallow hull sufficiently strong to support the weight of the engine at one end and the boilers at the other, the intervening space being filled with cargo, special fore and aft stiffening is fitted. This is supplied by three lattice girders, one on the center line and one on either side 6 ft. 4 in. from the center. These girders extend from the stern to the forward collision bulkhead, the center one to the



MIDSHIP SECTION OF STERN WHEEL RIVER STEAMER BUILT BY THE MERRILL—STEVENS ENGINEERING COMPANY.



HIGH PRESSURE ENGINE FOR STERN WHEEL STEAMER AND ENGINE FOUNDATION.

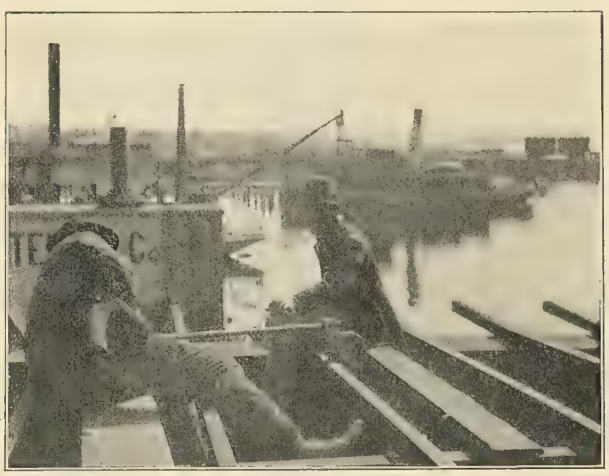


STERN WHEEL STEAMER CITY OF FAYETTEVILLE FOR NAVIGATION ON THE CAPE FEAR RIVER, N. C.

stem. In navigating shallow streams it has been found that the greatest wear of the hull is at the turn of the bilge, and to remove the bilge plates requires much time and expense. In this vessel, as well as other recent ones of this type, the bilge is made square and at the knuckle is run a 3 by 3 by 1-4 inch angle along the in-

SHOWING GENERAL CONSTRUCTION OF RIVER STEAMER.

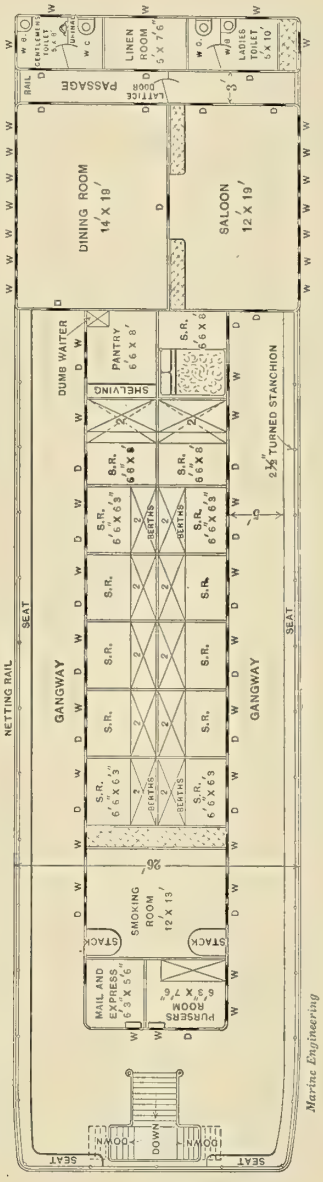
side of the plates all fore and aft; this angle takes all the wear and can be replaced at small expense. The construction of the girder is shown on page 281 with the view of the engine. The frames are made in one piece



PUNCHING DECK BEAMS BY HAND.

from side to side. The reverse angles run from knuckle to knuckle and are 2 by 2 by 3-16 inch. Deck beams are placed on every frame and are 2 1-2 by 2 1-2 by 1-4 inch angles. The hull is divided by four watertight bulkheads of 7 1-2 pound plating, and the lattice girders are intercostal between bulkheads.

At the forward end of the main deck are two water-tube boilers 7 by 9 feet each carrying steam at 200 pounds pressure. In the after deck-houses are accommodations for the crew, and the engine room. The stern wheel is driven by two high-pressure engines each 12 inches diameter by 60 inches stroke. The piston valve which is placed below each cylinder is 5 inches in diameter and is operated from the eccentric as shown. The engine and wheel are mounted upon a heavy tran-



SALOON DECK OF CITY OF FAYETTEVILLE.

som frame which is riveted to the deck and after bulkhead. The crosshead is carried by two wrought iron slides supported by the head of the cylinder and a bracket at the after end. The valve motion is controlled by the reversing lever, which swings through the arc X. This system of gear and arrangement of the valve below the cylinder is a distinctive feature of the Merrill-Stevens engine and has given great satisfaction. Its simplicity is apparent. In the engine room are mounted the various auxiliaries, including a small

direct driven dynamo. At the bow is placed a steam windlass. The vessel is steered by two balanced rudders with rudder stock running down the outside of the after bulkhead and supported by the transom. The two quadrants are yoked together above the deck and the steering gear leads to the pilot house. The stern wheel is made up of wrought iron rings and is 13 feet 6 inches diameter by 16 feet face.

The accommodations for passengers on the saloon deck are found to be much more commodious than usual in this type of boat. Forward are the mail, purser's room and smoking room, and then come ten staterooms 6 feet 6 inches by 6 feet 3 inches, and three larger staterooms. At the after end are the pantry, dining-room, social hall, lavatories and lockers. Above the saloon deck-house are the captain's and pilot's rooms, and above them, behind the two stacks, is located the pilot-house.

The designers have thus been able to build a complete steamboat, which, when loaded, will only draw 18 inches of water and will be capable of making a speed at 40 revolutions of the engines of 14 miles an hour.

REFRIGERATION ON SHIPBOARD.—II.
Points on Design.

BY E. N. PERCY.

Beginning at the source of power, which is usually a steam engine, it should be so designed as to operate the compressor at 70 to 120 strokes per minute. We assume an ammonia compression system to be used, as it is the preferred system today. The tendency, or at least the hope is among marine engine designers, to find some practical method, other than steam, of operating all of the auxiliary machinery. Three principal systems of transmission present themselves; they are electricity, air and hydraulic service. The near future may see our refrigerating plants driven by any one of these systems. The principal object of these efforts is to increase the economy of a very uneconomical class of machinery. The average refrigerating machine comes under this head with emphasis, when driven by a cheap steam engine. Not long ago, one of our naval engineers made an investigation of the economy of auxiliary steam engines. He was astonished at the amount of steam wasted by them. I do not recollect that his report mentioned refrigerating machinery, but it showed the importance of economy of the auxiliary machinery in general.

Taking the steam engine as generally applied to refrigeration, it should be solidly designed, with ample bearing surface, heavy flywheels and proportioned for shocks and stresses, due to the various demands of ammonia compression. The compressor may be connected tandem with the engine, or may be connected to another crank upon the same shaft. The latter way is preferable, as the balance wheel need not be so heavy, because the cranks can be so arranged as to have the engine turning moment at its maximum when the compressor is at the point of greatest resistance. The former way is the cheaper, but not to be recommended for economy or easy running.

Designers have seen fit to apply compound engines to generators, pumps and air compressors; why not apply them to the refrigerating plant? It would result in marked economy and smoother running. The double-acting compressors often give trouble by leaking at the rods. This seems to point either to using one large or two small single-acting compressors. Still, it seems as though double-acting compressors ought to work successfully if carefully constructed, and the oil seal glands designed with ample proportions, as the large machines of this class work well; but this necessitates a long machine, which is always more unhandy than two cylinders close side by side.

The enclosed type of compressor is very popular, as the crank pit can be connected with the suction of the compressor, and the shaft enclosed in a long stuffing box without oil seal, as a rule. This form, as usually made, while eliminating the leakage of ammonia, is open to many objections. Usually, the cover is on the side opposite the main bearing, necessitating an over-hung crank and a yoke, both of which are unsatisfactory in operation; and repairs can only be effected with much discomfort and loss of ammonia.

The proper proportions of the volumes and piping is a subject too complex to touch upon in this article, but in general, too little attention is paid to these points with small machinery of this class, and thus many a pound of coal has gone to waste. Throttle governors are usually used with these engines. A very successful form is a sensitive diaphragm governor attached to a butterfly valve, and operated by the pressure in the freezing coils; but in all cases, the regulation of the engine must be arranged so as to be instantly changed by hand.

If the brine and circulating pumps are attached directly to the engine and compressor, additional economy is realized, and the plant is simplified in piping and less floor space is required. With this arrangement, the plant must be started cautiously, and the expansion and compressor suction valves only opened enough to prevent a vacuum, until the brine and condenser water circulate freely.

If horizontal compressors are used, they should have horizontal valves, as vertical or oblique valves are bound to give trouble by wearing elliptical in time, and a very small leak suffices to displace the piston, and seriously reduce the efficiency of the compressor. In the best compressors, the whole head can lift like a large valve, in case the pressure becomes excessive, or oil or liquid ammonia gets on top of the piston. In oil injection machines this is a necessity to save occasional broken heads. The machine should be provided with an oil separator of ample capacity. It should be so designed as to prevent the oil foaming up, and being carried over into the condenser, and thus reducing its efficiency. There should also be a lime vessel to remove any moisture from the ammonia. This should be cleaned regularly. A by-pass with shut off valves should be provided so that the machine need not be shut down. Few machines on ships have this contrivance, yet it is most necessary, as water will get in from lubricating oils, from air and from leaks in the suction pipe in the brine tank. For the latter reason, the pressure of the brine in the tank (if closed) should never exceed the pressure of the ammonia, which should never be less than twenty pounds per

square inch, absolute, either for economy or leakage prevention.

Ammonia drums should be carried on deck, and permanent connections run from them to the machine, except where joint is broken at the drum. They should be shaded or covered from the sun and weather. The practice of keeping them in the engine room is dangerous and unscientific. The energy of a drum of liquid ammonia compares with that of gunpowder, and at 165 degrees Fahrenheit, it is at a pressure of 550 pounds per square inch. Hence all fittings and piping for the refrigerating machine should be tested at 800 or 1,000 pounds hydraulic pressure. This applies particularly to the condenser, as cases are on record (as mentioned in the last issue) where hot water has accidentally been turned into the condenser, raising the ammonia to alarming pressures for light fittings.

As for the expansion valves, the best are none too good. The automatic type of the best make is to be preferred. The closer they can be adjusted the better, as this is important in small plants; a slight change of the valve throwing the whole system out of regulation for an hour or more, until a balance is again reached.

The piping of the compressor should be so arranged that it can reverse its action and force its ammonia into the brine tank coils in case of leakage, or the necessity of repairs to the high pressure side of the system. This is very important, but is left off of many cheaper machines.

As to the men who have these plants in charge, the safety of the ship, as well as their economical operation and maintenance, requires that they should at least know what anhydrous ammonia is, and also something about the other low evaporative fluids used for refrigerating purposes. They should know every detail of the plant, and its functions. They should know about "wet compression," "dry compression," the heating of compressor cylinders, isothermal and adiabatic compression, why frost on pipes lowers their efficiency, what temperatures are best for certain provisions, and how to get clear ice from dirty water. The refrigerating plant would then no longer be an object of mystery to the owner and chief engineer alike. In the next article we shall treat of the design and operation of the ice house on shipboard.

Oil Steamers.—The lake built steamers *Northwestern, Northeastern, Northland* and *Northtown* are being converted into oil carriers for the Texas trade by the Morse Iron Works, Brooklyn, New York.

Oil Soaked Coal.—The Missouri, Kansas and Texas railroad has been conducting a series of experiments in the use of oil mixed with coal for fuel in its locomotives, and, according to the statement of officials, the new method has proved highly satisfactory, and plans are now being perfected for its general adoption throughout the whole system. The mixing is done by placing the coal in a large tank and thoroughly soaking it with Beaumont fuel oil, thus greatly increasing the steaming power of the coal. By using oil in this form no changes are required in the fire boxes of the boilers.

MODERN SEARCH LIGHT PRACTICE.

BY FRANK C. PERKINS.

Search lights used in the Navy Department of the United States government are fitted with parabolic ground glass silver plated mirrors, except the smaller sizes of 9 inches and 13 inches in diameter, which are supplied with Mangin spherical ground glass silver plated mirrors. While the quality of the light is not so white in the latter, they are not as expensive as the parabolic type, and are used extensively in most commercial projectors. The general design of the American search light as constructed in sizes from 9 to 36 inches by the General Electric Company is noted in Fig. 1. The hand control type is constructed in sizes up to 36 inches, and is arranged so that the beam of light can be trained vertically or horizontally by the operator stand-

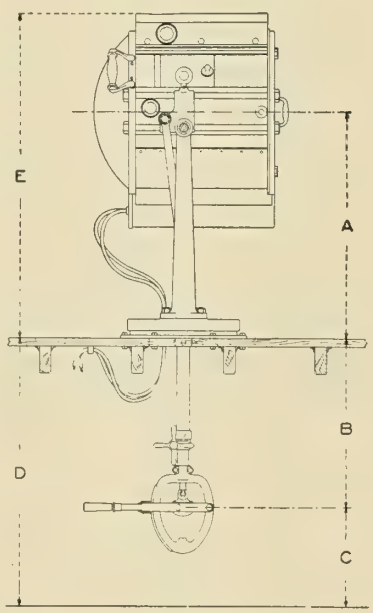


FIG. 1.—AMERICAN TYPE OF SEARCH LIGHT.

ing at the projector and moving the barrel in the desired direction with the handles.

A star wheel is mounted on the arm and clamps the quadrant part of the trunnion and acts as a locking device by means of which the barrel of the projector may be held at any desired angle. The General Electric pilot house control search lights are mounted on the top of the pilot house and operated from within. By the use of a single lever, which is located within easy reach of the pilot the light may be moved in either a vertical or horizontal direction.

The electrically operated search lights of this company are only made in the larger sizes having diameters of 2 feet, 2 feet 6 inches, 3 feet or larger. These search lights are controlled by a single switch or controller handle, which starts or stops the electric motors, operating the horizontal and vertical movements, according as the lever is moved to the right or left or up or down. This is quite an advantage, as the single lever simplifies the control and requires only one hand for the manipulation, while it will be noted that the controller

for electrically operating the Schuckert search light seen in Fig. 7, requires two handles, one for raising or lowering the beam of light and the other handle for moving the beam from right to left or the reverse. In the General Electric electrically controlled projectors, on releasing the handle it is brought back by a strong spring to the neutral position short circuiting the armatures of the motors and holding the projector locked in position. The motors in the base of the projector are connected to the controller by a seven conductor cable, and while one motor operates a train of gears controlling the vertical movement, the other motor operates another train of gears controlling the horizontal movement.

Schuckert designed and built machinery for grinding parabolic mirrors, as suggested by Munker, and these search lights have been adopted in several armies and navies, even in France, where otherwise Mangin's spherical mirrors manufactured by Sautter, Harle and Company, hold the field. The French search light is noted in Fig. 2, located in the fighting top of one of their modern war ships. The diagram of Fig. 4 shows some details of the electrically controlled search light of Siemens and Halske, of Berlin, while Fig. 3 shows a type of English projectors as manufactured by J. H. Holmes and Company, of Newcastle on Tyne.

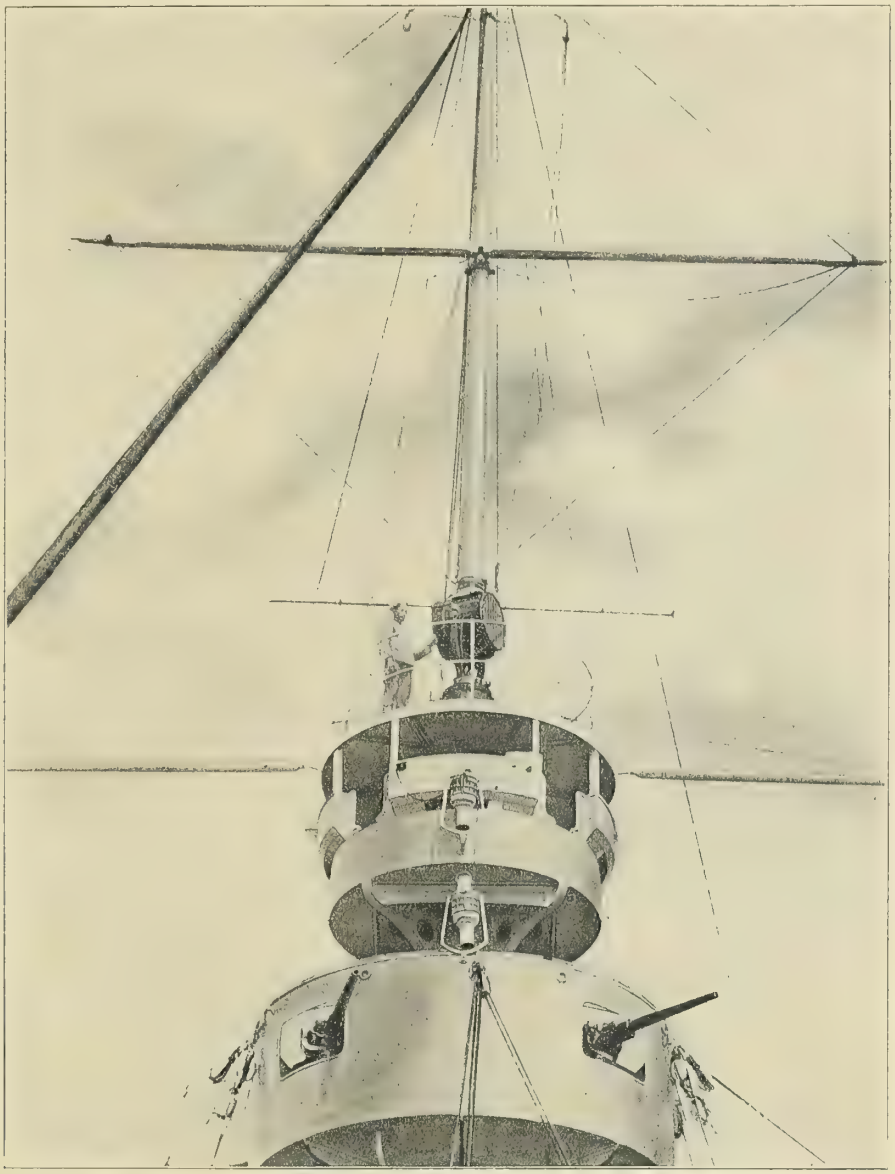


FIG. 2.—A FIGHTING TOP WITH SEARCH LIGHT.

The Mangin type of projector mirror has two spherical surfaces of different radii, and the reflection and refraction of the glass cause the rays of light to be projected in a parallel beam when the arc is in focus. The parabolic reflectors, however, produce a beam of light which is more penetrating, and the Schuckert projectors built at Nurnberg, Germany, have become very popular. In this form the mirror is supported in a

cradle in which it can be turned about its horizontal axis, while the cradle is fixed on a pivoted bedplate, as noted in Figs. 5-7.

In fortifications and on shipboard it is desirable to have two types of search lights, one for illuminating a wide belt for a short or moderate distance and the other for long range work for the intense illumination of an object such as a ship, torpedo or buoy. For the latter purpose the projector is placed high up in the fighting top or in as elevated position as possible, while for the former purpose, using a wide angle of light, it is placed near the water line, as in detecting and following up torpedoes. It is not convenient to have long and short range search lights combined in one, and when projectors are required to furnish a beam of light covering

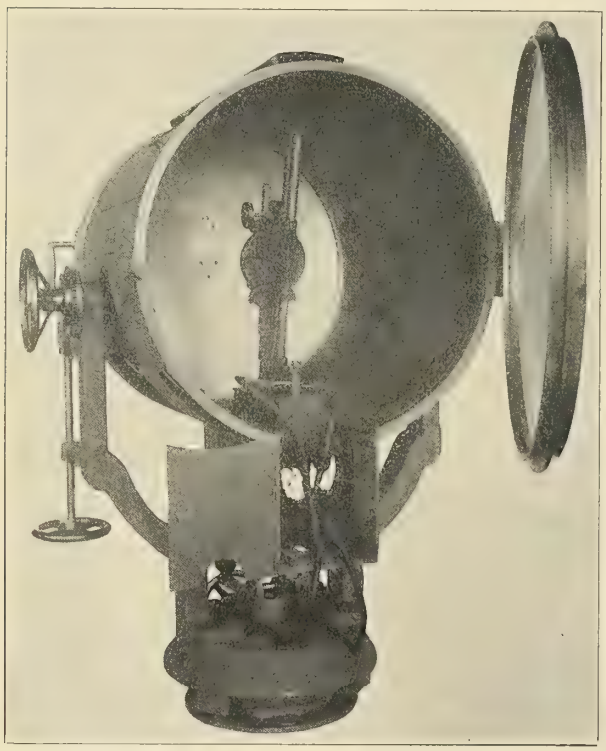


FIG. 3.—AUTOMATIC FEED SEARCH LIGHT.

a wide area, the General Electric Company furnishes a front door made up of strips of glass ground plano-convex, each strip being a lens, with the convex side outward. The beam of light passing through this door is diverged, making it wider but not increasing its height. These diverging doors for either 10, 20 or 40 degrees divergence are furnished for any projector.

Schuckert and Company provide single or double dispersers, the latter consisting of two systems of cylindrical lenses, whose distance apart can be adjusted, and the light thus concentrated in a parallel beam or dispersed to form a cone of 45 degrees. The single dispersers serve to spread the beam in one direction only (usually the horizontal), and consist of a series of plano-convex cylindrical lenses, set in a round frame, and supplied for angles of dispersion of 6, 12, 15, 20, 30 or 45 degrees. The double dispersers consist of two single dispersers, so superimposed that by bringing them together or separating them, either concentrated light of about 5 degrees, or any degree of dispersion up to 45 degrees can be obtained. In the dark spaces thus produced, shutters and signaling apparatus are arranged.

For marine purposes it is often necessary to be able to instantly shut off the light of a projector without interrupting the burning of the lamp. For this purpose

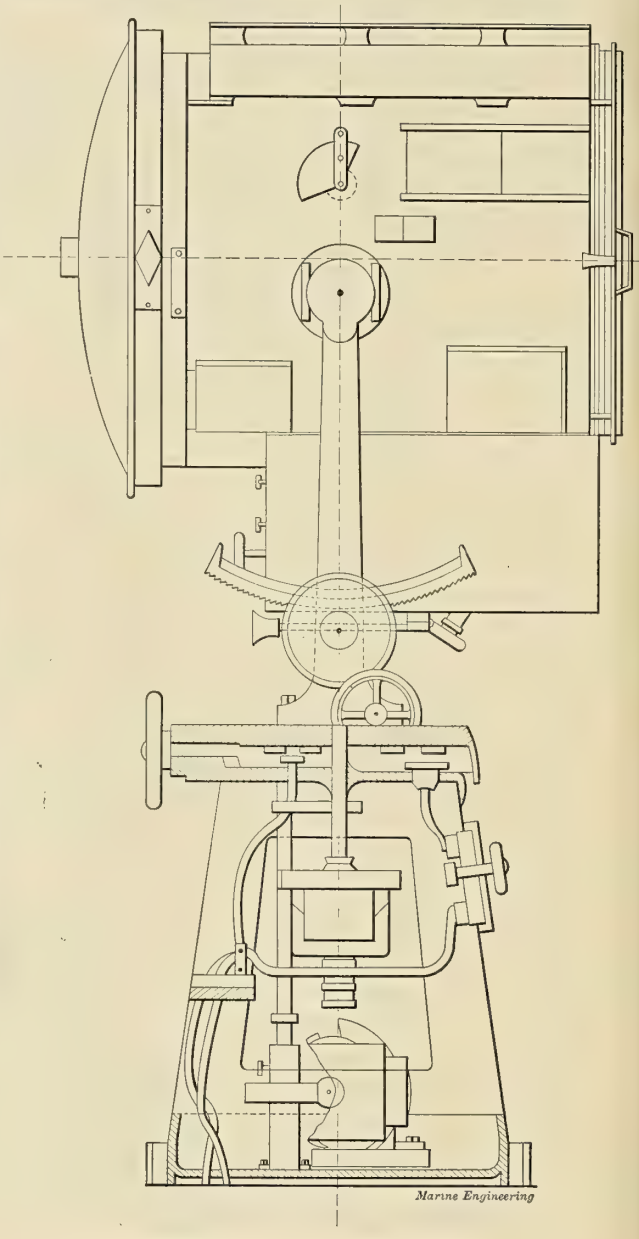


FIG. 4.—SEARCH LIGHT WITH MOTOR CONTROL.

the Schuckert projectors are provided with a special form of iris shutter, often used in photography, which, while easily controlled, possesses resistance against heat and is absolutely light proof. This type of shutter is noted, half closed, in Fig. 7, showing the enormous search light, 2,000 mm. in diameter and having 316 million candle power. This iris shutter is particularly well adapted for use with signaling apparatus. As the central part of the projector mirror (in consequence of the shadow of the negative carbon) does not give out

any effective light, the iris shutter, in spite of the center disk, in no way causes a loss of light. These projectors are sometimes supplied with horizontal automatic arc lamps with shunt winding and with simple arcing device and often with horizontal arc lamps, shunt wound with differential arcing device. These lamps burn two in series and adapt themselves for low primary potentials of 65 volts, and high currents of from 90 to 150 amperes, better than the lamps with simple arcing device.

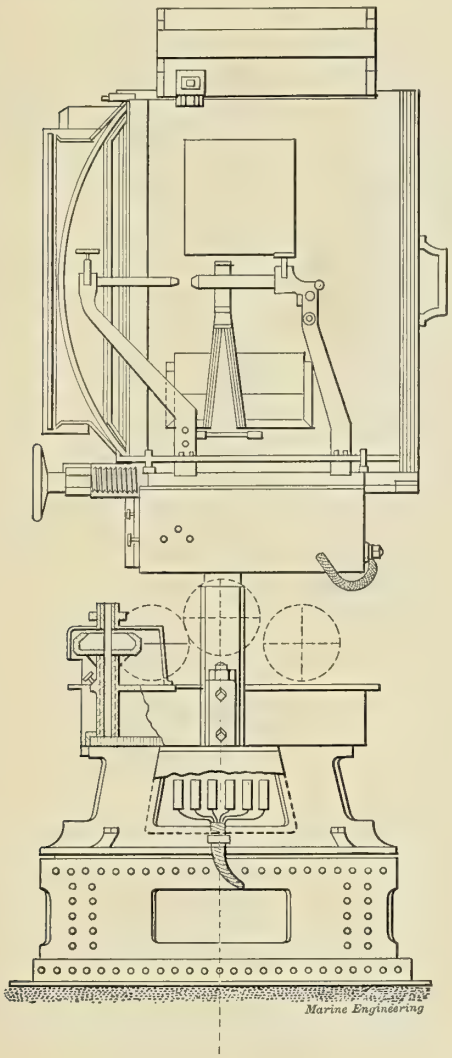


FIG. 5.—SEARCH LIGHT USED ON AUSTRIAN WARSHIPS.

The Schuckert search light projector for land and marine fortresses is seen in Fig. 6. It is fitted with a parabolic ground glass mirror 1,500 millimeters in diameter and has a total power of 180 million candle power. It is arranged for electric motor control, two shunt wound motors being used of the inclosed type. The motors have ball bearings and carbon brushes and are designed for reversible working, with worm gearing and transmission device for turntable.

When the single switch lever is used, it permits each movement to be effected separately, and is provided with armature short circuit brake. The double switch lever arrangement is for both horizontal and vertical directions of movement, and allows both movements to be effected simultaneously. Both levers are provided with armature short circuit brakes to stop the motors suddenly. This device is seen in Fig. 7 connected to motors of the projector by cables, which may be of any reasonable length.

Search lights for military, naval and mercantile marine use are designed differently and with special reference to the work they are to do and the nature of their location. The torpedo boat search light usually has a parabolic glass mirror of from 350 mm. to 400 mm. in diameter, and weighs from 80 to 120 kilograms. It has sometimes hand regulated and sometimes automatic horizontal arc lamps, usually operating at from 30 to 50

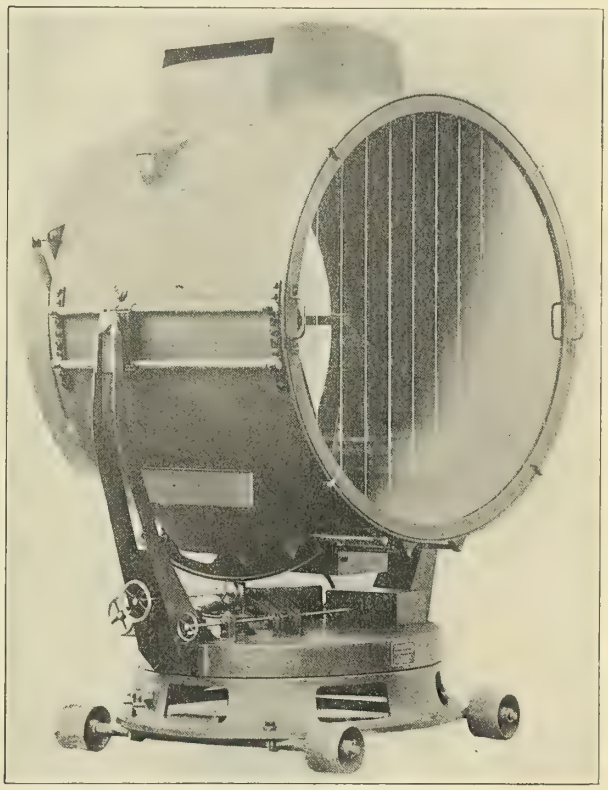


FIG. 6.—180 MILLION CANDLE POWER SEARCH LIGHT.

amperes. Bronze frames and cases are frequently made use of, while for military purposes, aluminum frame and case construction is the rule abroad, with parabolic glass mirrors of 350 mm. in diameter and aluminum automatic lamps using a current of about 22 amperes. This entire outfit only weighs 18 kilograms.

Projectors for naval transport steamers, and for trade and cargo vessels, are usually mounted on high sheet metal pedestals, with parabolic and often Mangin glass mirrors 450 mm. in diameter, with often hand feed and sometimes automatic horizontal arc lamps of current capacity from 40 to 50 amperes and weighing from 170 to 195 kilograms.

The largest search lights are used for naval and large mercantile ships, and have parabolic glass mirrors 600, 750, 900 mm. and even 1,100, 1,500 and 2,000 mm. in diameter, as noted in Figs. 6 and 7. These large pro-

jectors are usually electrically operated by motors and are equipped with dispersers, and iris or other types of shutters according to the country in which they are manufactured. The currents vary for the horizontal arc lamps from 60 to 200 amperes, and the weights from 490 kilograms to 990 kilograms, and even much greater in the 1,500 mm. and 2,000 mm. search lights of Schuckert and Company, ranging from 180 million to 316 million candle power.

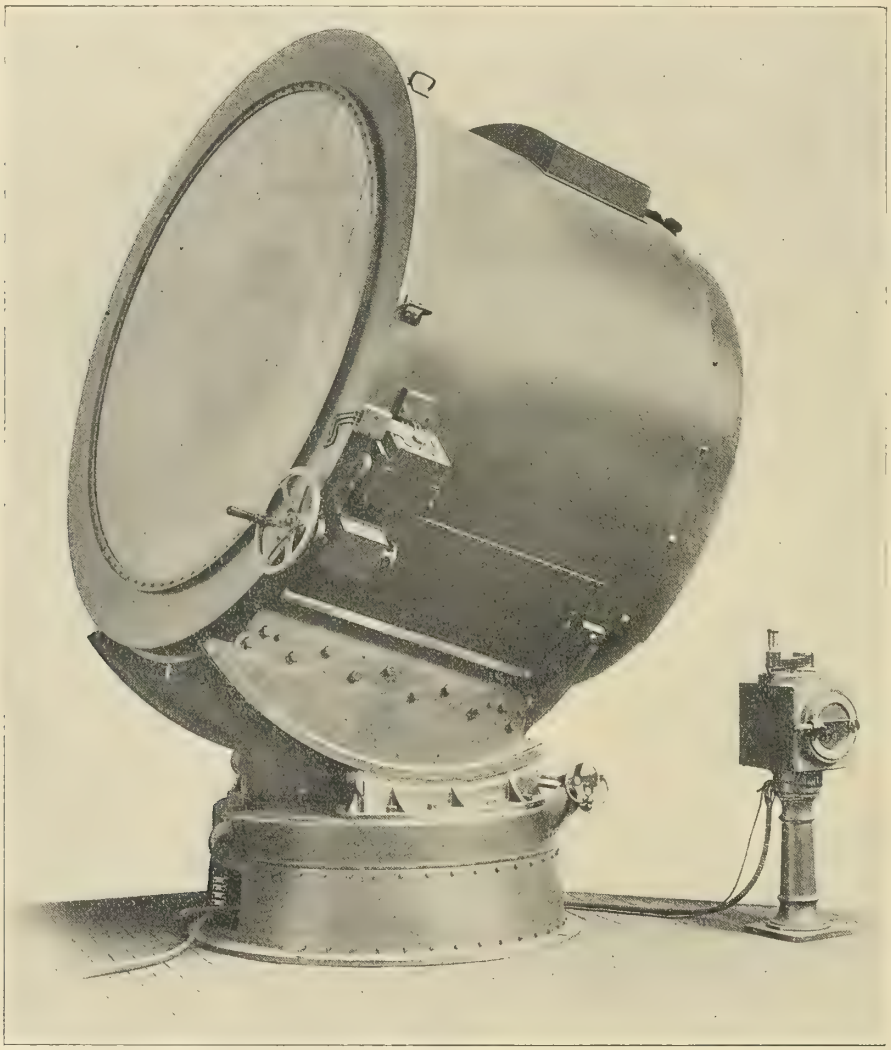


FIG 7.—316 MILLION CANDLE POWER SEARCH LIGHT.

Turbine Driven Torpedo Boat.—The British Admiralty have ordered the construction of another turbine driven torpedo boat destroyer.

Monthly Shipbuilding Returns.—The Bureau of Navigation reports 115 vessels of 79,753 gross tons built in the United States and officially numbered during the month of April, 1902. The largest steel steam vessels included are: *Shawmut,* 9,606; *Alaskan,* 8,671; *Minnewaska,* 5,273; *City of Memphis,* 5,252; *Etruria,* 4,744; *Bransford,* 4,744; *Stel King,* 4,308; *William Nottingham,* 4,234. The foregoing figures do not include craft without motive power of their own.

BEAM ENGINE VALVE GEARS.

BY THEODORE LUCAS.

The large amount of literature that in text books and current publications deals with the important subject of marine valve gears and their steam distribution, is devoted almost exclusively to the form of the common slide or piston valve, and its forms of radial or link reversing mechanisms. It may not be untimely, however, to pay a well-deserved tribute of recognition to the designers and constructors of the distinctively American beam engine and point out the remarkable accuracy and perfection of its steam distribution by a form of valve gear, which, although apparently cumbersome, is remarkably free from possibilities of derangement and affords the greatest possible adaptation to the purpose.

The beam engine has been retained in American marine practice in a form closely resembling Watt's original steam engine construction.

Under our American conditions of a nearly complete absence of over-sea steam shipping, there was no in-

centive to discard the beam engine for service in sheltered waters, as ships with high deck erections can conveniently accommodate the necessary engine shaft. It was the high perfection of the steam distribution by its valve gear that enabled the beam engine to attain, even with low pressure, remarkable economy of coal consumption, which advantage, coupled with few breakdowns and small repairs, made it for a long time an economic success.

The general arrangement in Fig. 1 shows clearly the separate steam and exhaust valves for top as well as bottom ports with their lifting rods and operating cams. Through this complete separation of the valves, it is possible to operate the two separate halves of the rockshafts by the end rockarms from eccentrics that may differ in their angular advance, with the consequent important modification of the steam distribution.

Additional variation may occur in the steam and

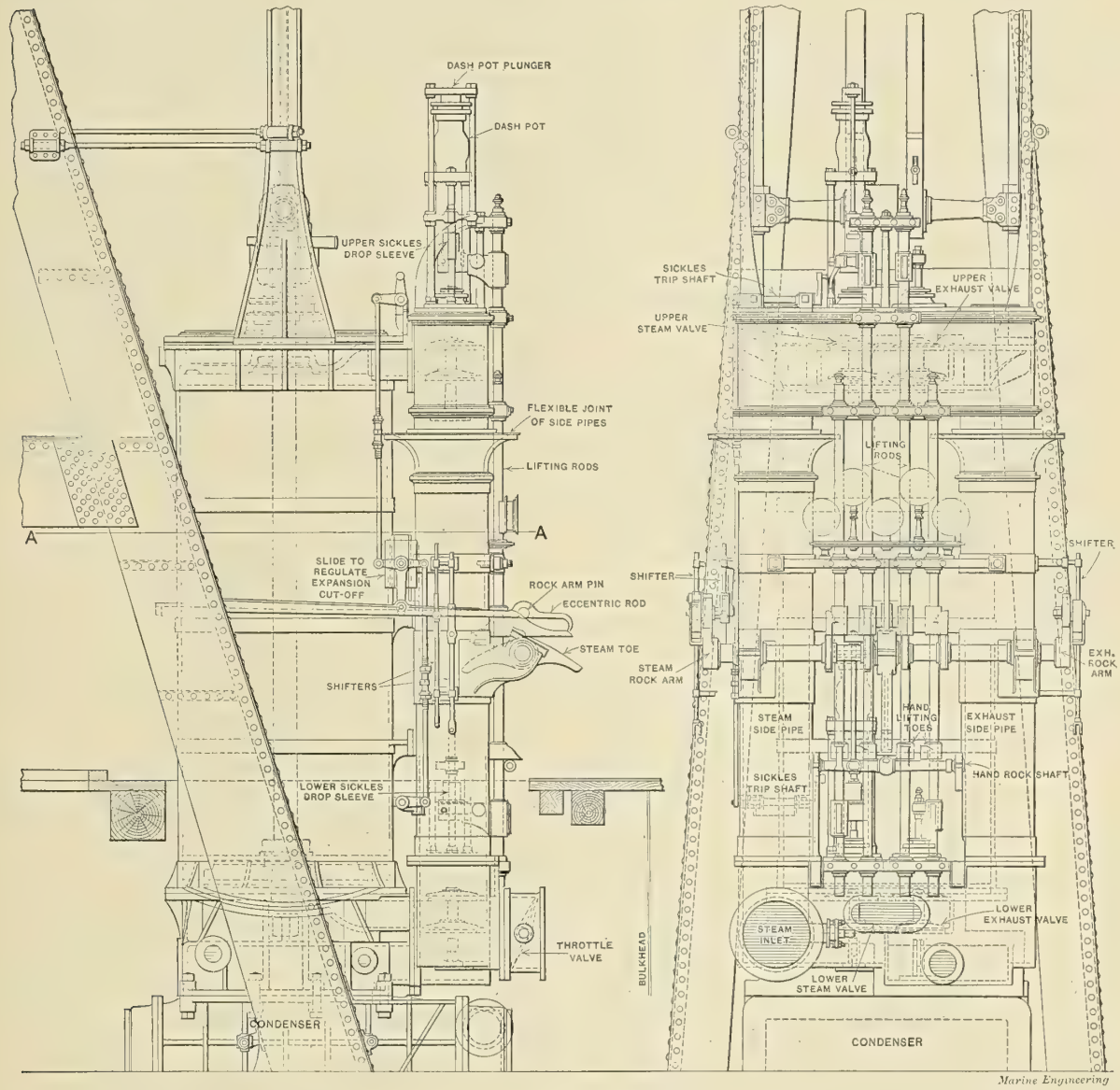


FIG. 1.—SIDE AND FRONT ELEVATION OF A BEAM ENGINE.

The modern poppet-valve gear shares with another production of American engineering genius, the Corliss engine, a number of features that make their functions of remarkable accuracy and precision. The distinctive feature is the introduction of separate steam and exhaust valves. It is thus possible to avoid the compromise, as required for slide valve engines, and to bring out the needs of every period in the steam distribution in full prominence and within wide limits.

exhaust lifting cams in their length, shape and position on the rockshaft, which position determines how much of their swing is actually working stroke. It may prove interesting to show the great variation that can be realized in the indicator diagram by the modification of the different factors. Through the intermittent action of the cams and through the light weight of the valves, a comparatively large stroke and rapidity of opening and closing can be secured, which shows very

favorably in actual cards by an almost entire absence of wire drawing.

The diagrams shown are of a simple elliptical pattern, giving readily a complete insight into the steam distribution, although the ellipse is somewhat distorted by the intermittent action of the gear. The diagrams are developed by representing the piston revolution vertically at 24 equal divisions of the crank circle, while the swing and lifting action of one steam toe and of the corresponding exhaust toe, indicate horizontally the position of the valve that corresponds to these crank and piston positions. Below the toes is given the arc of the rocker arm, which effects their swing, numbered according to the angular advance of the eccentrics. Fig. 2, 3 and 4 show that numerous combinations may be made. As determination of beamengine steam distribution by diagrams is of somewhat rare occurrence, a little difficulty was experienced as to how all the important factors might be represented in a simple form. The diagrams, as shown, appeared to offer the best solution, as they present the following items:

1. Angular advance by the number on the arcs of the rocker pin and the toes.
2. The length of the toes.
3. The shape of the toes.
4. The position of the toes on the rockshaft and the arc through which they are actually lifting.

The influence of variation in the angular advance is clearly seen by a comparison of Figs. 2 and 3. As the lead in the valve gear is more or less a constant quantity, determined by the consideration of fully established steam pressure behind the piston at its end position, it follows that variation of the angular advance has to be accompanied by a shifting of the toe on the shaft until the best lead is again established. The steam toe in Fig. 3 had to be turned down one division of 15 degrees, crank angle with consequent decrease of the steam lift, but with the effect of making the cut-off earlier by 2 divisions. A limit to the turning down and increase of the angular advance is set by the decreased opening of the valve up to the point where wire drawing of the steam would commence.

For the exhaust toe Fig. 2 presents a case analogous to negative exhaust lap in a slide valve, which means that the exhaust period extends over more than one full stroke. From Fig. 2 it is seen that the advance exhaust opening and the compression increase or decrease at the same time, due to this excess of exhaust period. Fig. 3 indicates how, by the turning down of the toe, the period is decreased to less than one full stroke with a consequent possibility of a fixed advance exhaust opening and of regulating the compression to a desired degree.

The length of the toes may have an important bearing upon the lift of the valve, as it is evident that a steam toe of double the length swinging through the same arc will raise the valve approximately twice the former distance. The point of practicability is the main one to be considered. The toes should not be too unwieldly and clumsy nor bear at the end of the swing only on a narrow edge. The relation between the length of the toe and that of the rocker arm and the stroke of the eccentric enter also into the consideration, in order to prevent the angels A or B from attaining a value much more than 45 degrees. The influence of the shape of the toes is presented by Fig. 4 as a modification of Fig. 3 by substituting entirely straight toes for curved ones. It is evident that absolutely straight toes would be undesirable for smooth working, as producing shock and wear; but a certain amount of straightening in the toes may sometimes make desired modifications possible in the steam distribution.

The position of the toe on the rockshaft and that part of the arc during which lift of the valve occurs are regulated, as stated, by the consideration of lead and angular advance, with due consideration for the prevention of wire drawing the steam.

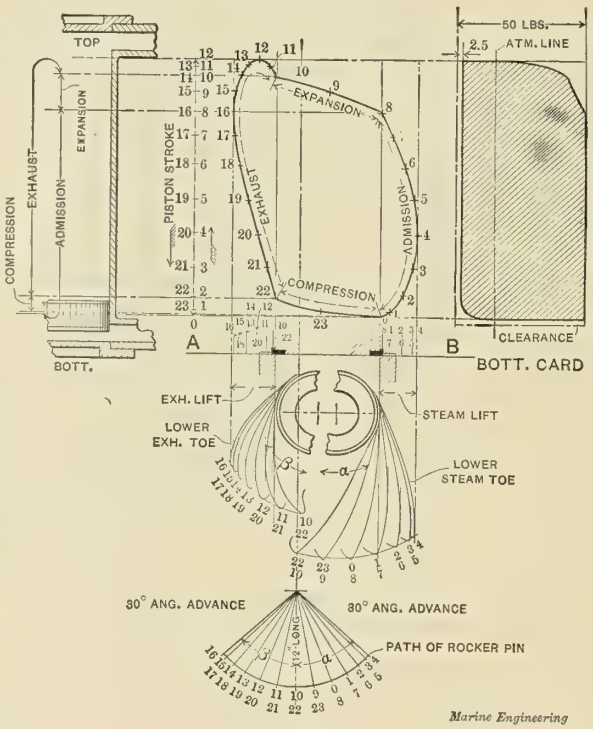


FIG. 2.—VALVE DIAGRAM.

Especially in the older beam engine, permanent provision was occasionally made for turning the toes up or down, as deemed best by the operating engineer. In some cases the exhaust toes were rotated on the main rockshaft by small eccentrics on a slide shaft, but this arrangement has been abandoned as too complicated and less secure than keying in the desired position.

The conditions of beam engines with their relatively low piston speed and small clearance spaces make it easy to secure very large openings in the valves, and the cards taken show a remarkable sharpness found nowhere else except in the Corliss engine. Fig. 3 presents a case with a cut-off at about the desirable limit, as further decrease of the cut-off would necessitate either longer or straighter steam toes or smaller valve lifts. This normal arrangement is known by the name of the Stevens cut-off, in honor of a member of the family, whose name is so intimately associated with the development of American marine engineering.

To secure still shorter cut-offs, a special drop cut-off, known as the Sickles gear, is employed. Fig. 5 shows an arrangement as applied to an upper steam valve. The gear is operated by a special cut-off eccentric which by lever transmission forces little slides on the valve stem arms at certain positions, to the extreme end of their paths, thereby releasing the valve and valve stem from the support of the arm and allowing them to drop to the valve seat. To prevent a destructive blow, an overhead dashpot is connected to the valve stem, which retards the motion toward the end of the stroke and helps to seat the valve gently. The disengagement of the valve stem is produced by the partial rotation of a ring through gearing by the stroke of the slide. This ring has a number of inside teeth which correspond to an equal number of outside teeth on a long sleeve secured to the valve stem. By rotation, the ring may bring its teeth under the teeth of the sleeve and, being firmly held by the lifting arm, carry the valve stem and the valve with it.

If, after further rotation, the teeth of the ring are brought under the grooves of the toothed sleeve, and the grooves of the ring under the teeth of the sleeve, the support is lost and the stem and valve drop, causing the sleeve to slide through the ring. After the lifter and its arm have completed their stroke, the ring is rotated back by a spring to its original position, ready for a new lift with the arm.

The release of the valve occurs when the actuating lever pushes against the pin on the slide, carrying the slide with it to the extreme position. If it should be deemed desirable to have the cut-off at division 4, Fig. 3, then the cut-off eccentric, for an arrangement as shown in Fig. 1, would have to be approximately either 120 degrees ahead or 60 degrees behind the crank to obtain the desired result. It is apparent that the shifting lever will pass the pin and slide twice during each revolution of the shaft, but also that only the passing at position 4 of the crank will be productive of results, as at the other position the lifter, arm, valve stem and valve are at rest and the ring will rotate loosely back and forth.

A peculiarity of the beam engine may also be observed in the reversing gear. Link gear, as formed in vertical engines, is entirely unknown. The eccentric rods in beam engines connect to the rock arm pins only by open slots which hook from above over the pin, as seen in Fig. 1. Through the shifters, the ends of the eccentric rods can be raised until free from the pins, thus cutting off the automatic control of the steam distribution. To keep the engine under control, a special rockshaft, with small steam and exhaust toes, is arranged, and by manipulating this through a hand lever, the valves are lifted and the steam is distributed according to the desire of the engineer, for ahead or backing motion. As the strokes per minute are few, this arrangement proves quite effective in the hands of experienced engineers, who, with the help of a dial showing at the platform the exact position of the crank, can time the steam distribution in a satisfactory manner.

Where reversals occur frequently, as in ferry boats, backing eccentrics and eccentric rods for steam as well as exhaust are fitted which are also provided with shift-

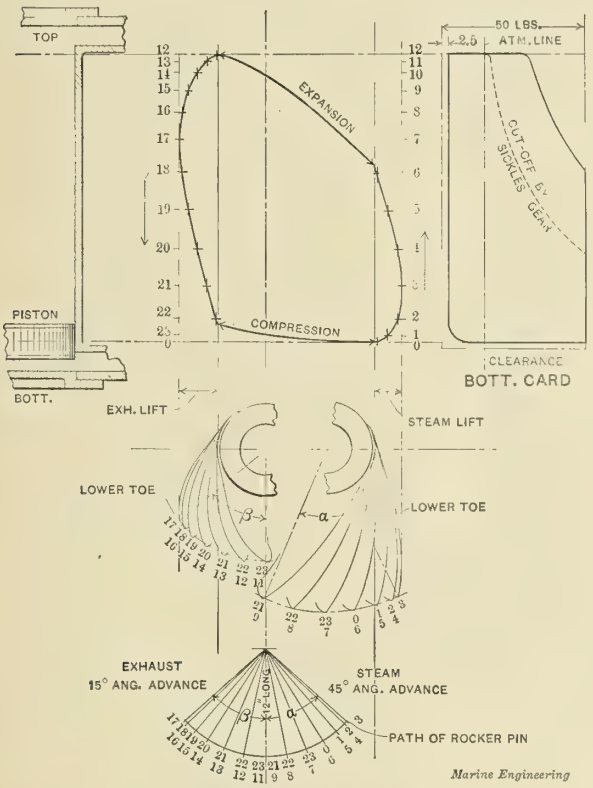


FIG. 3.—VALVE DIAGRAM.

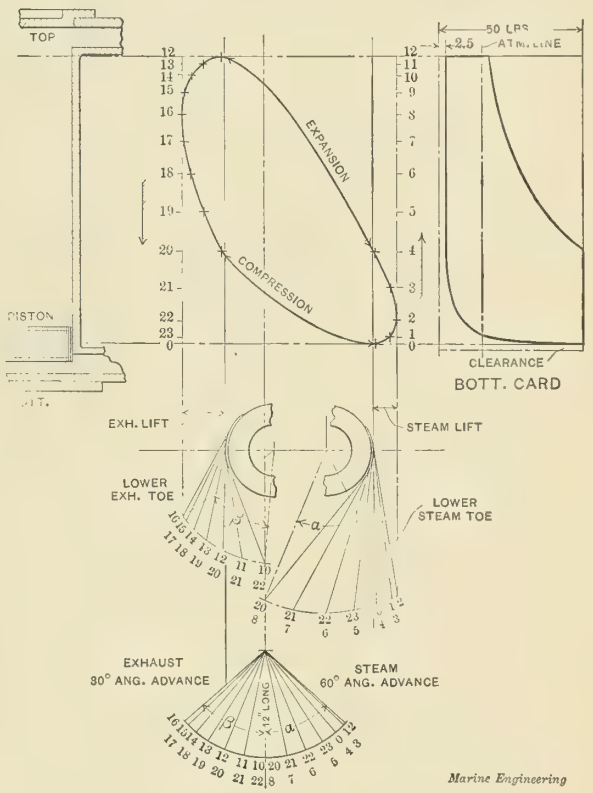


FIG. 4.—VALVE DIAGRAM.

ers and which, upon lowering, hook on to a special extension of the rock arm pin. It is evident that the ahead and backing shifters must be so connected that if one eccentric rod is hooked on, the other one is lifted off.

the very successful engine of the steamer *Bay State*, of the Portland-Boston route, as built by the firm in 1894. From other notes, data and diagrams kindly furnished by this company, the writer was enabled to develop the diagrams as shown.

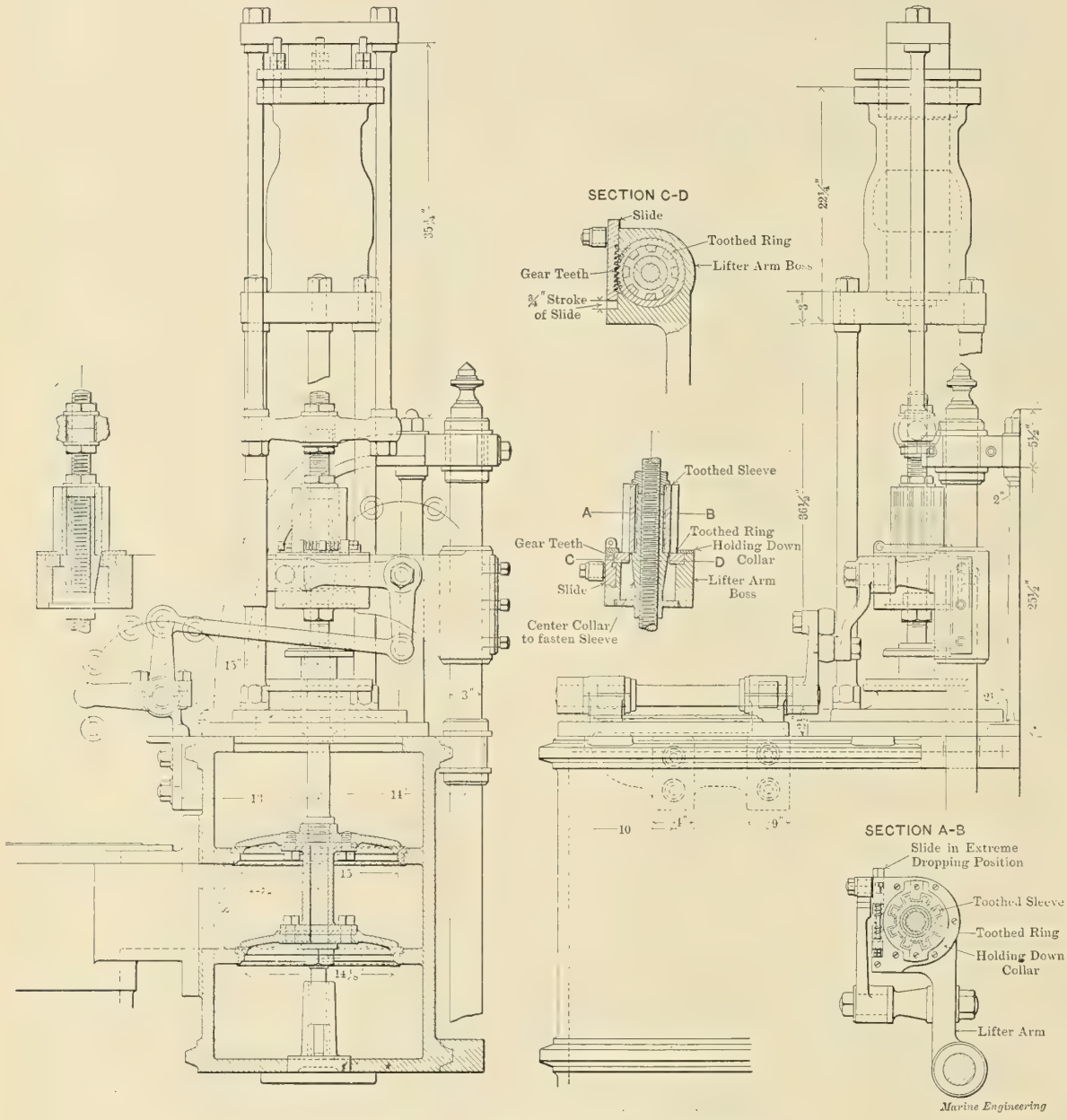


FIG. 5.—DETAIL OF VALVE AND CUT OFF ON A BEAM ENGINE.

The beam engine offers one of the most original developments of marine engineering and has held for a long time an almost unchallenged popularity in river, bay and sound steamers, giving way but slowly under the overwhelming advantage of the higher steam pressure and decreased weight of more modern constructions.

The Figs. 1 and 5 are presented through the courtesy of the Portland Company, Portland, Me., and represent

Huge Lumber Raft.—A raft containing 11,000,000 feet of logs equivalent to three times the dimensions of the ordinary log raft, has recently been floated down the Mississippi. Two river steamers were used for controlling the raft, one, engaged in towing head, while the other was used as a bow boat to swing the big float back and across the shallow steamer to avoid shallow water and difficult places.

ELECTRIC IGNITION.

BY DONALD M. BLISS.

The past few years have witnessed a great development in explosive engines for marine and automobile use. There are a number of designs now on the market which are thoroughly well built, efficient in operation and reasonable in price. It is to be regretted, however, that no perfectly satisfactory system of ignition has yet been found; and there probably is no detail in a gas or gasoline engine so productive of annoyance and delays as the apparatus or method for exploding the charge. As either the jump spark or wiping contact methods are almost universally used, our remarks will not include hot tube or automatic explosive devices.

Gas engine manufacturers have devoted much time and money in search of a satisfactory electric igniter; but as the principles involved belong to the field of electrical engineering rather than engine building, and the conditions governing their satisfactory operation are unusually trying, it is not surprising that so far the efforts of the engine manufacturers have not been crowned with success. In many cases the purchaser of a gasoline launch is carefully educated regarding the special merits of the various engines on the market in general, and the one he selects in particular, but is left in comparative ignorance regarding the most satisfactory arrangement for ignition and the proper care of the battery or dynamo used for the purpose.

There are, broadly speaking, two methods of generating current: the battery system and dynamos. The former includes primary batteries as well as storage batteries, and the latter may also be divided into two classes, including the dynamo and magneto generator. The character of the current produced by any of these should be alike as to volume or quantity and pressure or voltage, and in all cases direct current should be used, and not alternating. The use of a magneto generator similar to that used for telephone service has been frequently proposed and tried. This form of generator, as is well known, delivers a current alternating in character, and there are, therefore, two positions in the revolution of its armature when the pressure is zero and no current generated. It is impossible to overcome this effect in the alternating current generator, and, therefore, when the engine is in operation, the sparking contacts may be operated just at the instant the generator is not producing a current, and there will be consequent failure to explode.

Regarding the method of ignition the wiping or touch contact arrangement is much to be preferred for marine engines, owing to the ever present moisture and the resulting difficulties in securing the high insulation necessary for proper operation of the jump spark. Batteries of the open circuit form are frequently advised, and used by the inexperienced, but a short trial will convince one that this type of battery is not at all adapted for continuous use. Such a battery, whether of the dry cell or liquid type, weakens very rapidly under the severe conditions imposed, and while the first cost is low, the frequent renewals necessary render their use the most expensive method of generating current. For this purpose batteries of a closed circuit form, such as the Edison Lalande, are quite frequently used, and these, owing to their greater current capacity and low internal resistance, are much more satisfactory. These cells are quite expensive, however, and supplies or renewals not easily obtained on extended trips, and owing to a solution being required, they are liable to accident and breakage.

Storage batteries are sometimes advised, and when properly installed and under careful supervision they give excellent results, both in staying power and quantity of current generated. The use of storage cells, however, involves the necessity of frequent charging, and it is often difficult to find the required current for this purpose when away from headquarters. There is a decided tendency at this time to discard the use of batteries in any form and rely on the igniting generator of either the dynamo or magneto type.

Before considering the respective merits of these two machines it may be well to consider the condition imposed on the generator by the modern wipe or touch contact system.

When the contacts in the cylinder are closed the electric circuit includes only the generator, a spark coil, the contacts, and a few feet of conducting wire. As the resistance of the spark coil is usually very low and that of the wire and contacts almost negligible, it will be seen that the generator at this instant is run almost short circuited, or under an extreme overload. As soon as the contact separates, and the spark is made, this condition is completely reversed; the circuit is open and the load is removed from the generator until the next contact is made. The dynamo is therefore run under a rapidly intermittent load. While the average amount of energy required to produce a satisfactory spark is small, the dynamo must be designed to operate under this intermittent overload without sparking or overheating at the machine itself. The commutator and brushes are without question the weakest parts of these small machines, and it is just here that the owner of a gasoline launch will find the most annoyance. The brushes used on most dynamos are almost invariably too small and the holder and connections flimsy in construction.

It is absolutely necessary that both the commutator and brushes be kept clean and free from dust and oil, and the generators should be so designed that while these parts can be completely enclosed and protected while in operation, the protection can be readily removed so that free access may be had for cleaning and examining brushes and commutator. The kind of brush to be used depends considerably on the style of machine and the voltage or pressure for which it is wound. In general it may be stated that machines delivering from 15 to 25 volts will operate more satisfactorily with a carbon brush, providing the holder is large enough and has satisfactory means for securing a good tension on the brush itself. The writer has found a composite brush made of copper gauze imbedded in carbon most satisfactory for this work. The copper gives the required conductivity and the carbon preserves the commutator, thus securing the sparkless operation so necessary to the life of the machine. If the generator is wound to give a low pressure of 5 to 10 volts, the only reliable brush is one made of leaf copper or copper gauze. The commutator itself should be made of the best hard rolled copper only, and a machine having brass or composition segments should not be accepted. As

these generators are operated frequently at very high speeds, and unfortunately receive very little attention, the shaft bearings and method of lubrication should be perfect. Bearings of the best phosphor bronze, provided with grease cups and suitable feeding device, give the most satisfactory results in the long run.

The above remarks, covering brushes and commutators apply to machines of both the dynamo and magneto type with equal force.

The chief objection to the all copper brush is the destructive effect on the commutator caused by the slight spark, which is characteristic of improperly designed machines operating an intermittent load of this character. The relative merits of magneto and dynamo types of machines are frequently discussed, but there seems to be little uniformity of opinion as to the best type for any given case.

A Salvage Case.—Judge William T. Townsend in the United States District Court recently handed down a decision in which he held at fault steamship *La Bourgogne,* of the French Line, for colliding on April 4, 1898, off Sable Island, with the British ship *Cromartyshire.*

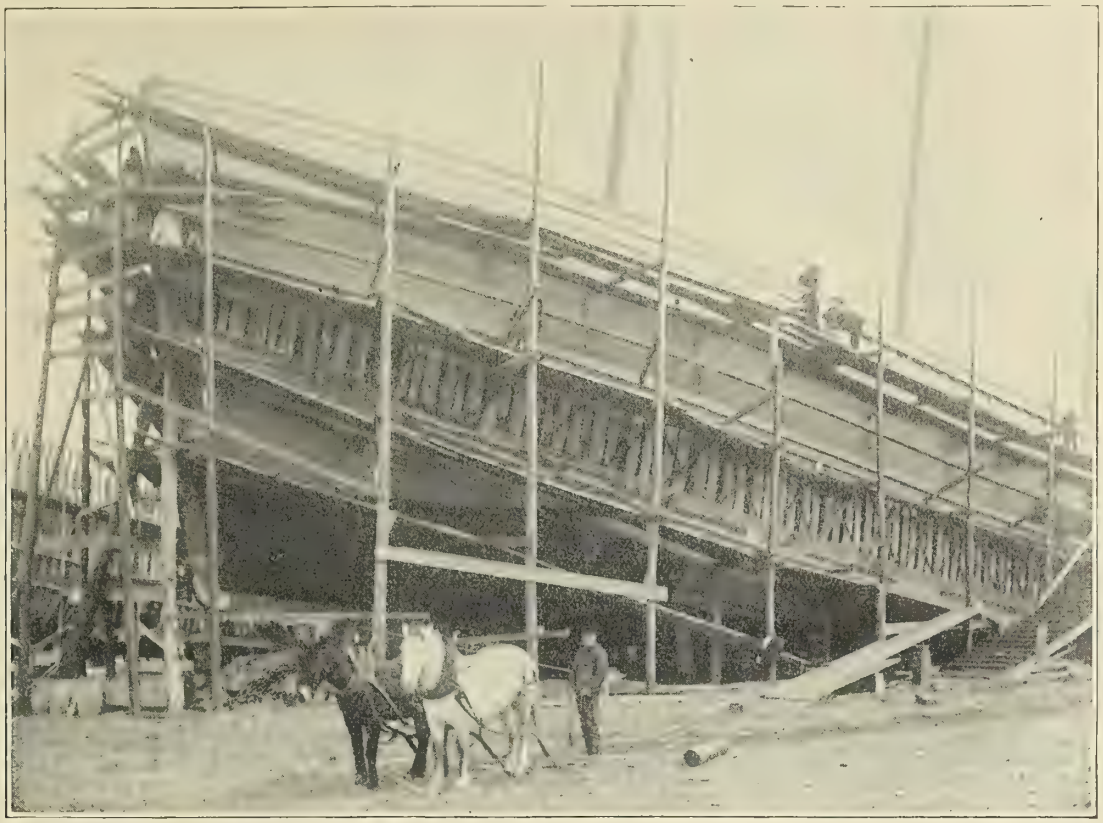
Fleet of Oil Steamers.—It is stated that the steamships owned by the American-Hawaiian Steamship Company are all to be converted into oil burners. The oil will be supplied to the ships at New York, Straits of Magellan and San Francisco. The supply at the Straits will be given the passing steamers from tank steamers stationed there.

Large Wooden Barges.

An important innovation in wooden barge construction is exhibited in the two big barges *Cienfuegos* and *Santiago,* now being built for the Staples Coal Company, Taunton, Mass., at the yard of Kelley, Spear and Company, Bath, Me. This is the strapping of the frames together with diagonal bands of steel. This method of construction has been used heretofore in the building of steamships and the larger schooners, and in fact is required in the classification of wooden vessels of over 1,000 tons burden whose length exceeds ten times their depth, but it has not before been used at any of the yards in this section in the building of barges. The great length of these barges in proportion to their width and depth, and the fact that their bilges are thus unusually wide and flat and that they are intended for long voyages instead of the coastwise service, have induced the owners to adopt this mode of construction, of course at an increased cost.

LARGE WOODEN COAL BARGE BUILT AT BATH, ME.

The dimensions of the *Cienfuegos* and *Santiago* are as follows: Length over all, 280 feet; breadth, 46 feet; depth, 19 feet; carrying capacity, 4,000 tons. They are 40 feet longer, three feet wider, and their carrying capacity is a thousand tons more than barges of the *Matanzas* and *Cardenas* type, which were built at this yard last spring, and were at that time the largest ever constructed here. The method of setting up and fastening the frames of these barges is similar to that employed in the construction of the larger schooners. The frames are of hackmatack and birch and the planking and ceiling of hard pine. An idea of the strength of their construction can be gained from the fact that the



PLANKING THE CIENFUEGOS.

DECK OF WOODEN BARGE CIENFUEGOS, LOOKING FORWARD.

nine keelsons are each 14 by 14 inches. The planking is of 5-inch stock and the ceiling 12 inches.

The method of strapping will perhaps be of interest. The belt strap, which extends around the top of the barge from the stem to the transom, is 8 inches in width by 3-4 inch in thickness. This strap is bolted to every frame, the ends of the bolts being secured on the inside of the frames by countersunk nuts. The diagonal straps extend from the belt strap at the top down to the slant floor at the bottom of the barge, running parallel to each other at a distance of 5 feet, a second series of parallel bands crossing the first at right angles. Where these bands cross the frames they are secured to them in the same manner as are the belt straps, and where they intersect between the frames they are riveted together with hot rivets. They are also riveted to the belt strap at the top. Grooves are cut on the outside of the frames after they are set up so that the straps are sunk below the surface and the planking can be put on smoothly over them. The planking is treenailed to the frames throughout, instead of only up to the water line as is the method of construction adopted at some yards. The butts of the planking are secured by galvanized bolts. It will be noted that this substantial network of steel strapping renders these vessels especially capable of sustaining the great strain that naturally falls on the bilges in a vessel of this length with only a single deck, and obviates all danger of the bilges dropping down.

The *Cienfuegos* and *Santiago* will have four masts and will spread 2,500 yards of canvas, an unusually large amount for a craft of this class. The generous supply of canvas carried by the barge *Cardenas* proved to be especially serviceable when she broke adrift during a recent storm. These barges will be even better equipped in this particular. Their rigging will be of wire throughout.

As these barges are designed especially for the Cuban trade and will carry large unassorted cargoes, their holds are not divided into separate compartments as is the case with the smaller barges designed merely for the coasting trade. They will each have six hatchways, which will greatly facilitate the discharging of cargoes. Each barge will be equipped with a No. 9 steam windlass of the Hyde type, and two hoisting engines, and each will carry two 4,000 pound anchors and 180 fathoms of 2-inch chain.

They have but one house, situated well aft. The wheel room and crew's quarters are located directly over the captain's quarters, which are on deck. These quarters are finished in pine, grained and varnished. The best of material is used and the greatest care maintained throughout the entire construction of these craft to make them perfectly stanch and seaworthy, capable of carrying for long distances their heavy cargoes safely even in the face of heavy gales and high seas.

The barges will each carry eight men besides the captain. The *Cienfuegos* was launched ready for sea the last of March, while the *Santiago* is soon to go overboard.

SCHOONER WRECKED BY COLLISION AT ST. JOHNS, N. B.
(Photo. by Conton, St. Johns, N. B.)

Collision at St. Johns, N. B.

The packet schooner *Princess Louise* was run down and wrecked February 12th by the steamer *Prince Rupert* during a heavy fog. The little vessel was anchored in the harbor at St. Johns, having come in from Grand Harbor, Grand Manan. She anchored directly in the path of outgoing steamers, and was

shortly after run down by the *Prince Rupert*. The schooner, as is clearly shown, was a total wreck, the sharp bow of the *Rupert* having struck squarely on the stern of the schooner, cutting through from deck to keel. The port bow was not damaged, while the starboard bow was dug out from the stem to the bulkhead. The schooner was towed at high water on to the shore and beached, as seen in the illustration.

Explosion of Boiler.

Shortly after one o'clock on the night of February 5th, the boiler of the Pittsburg Harbor towboat, *John W. Ailes*, exploded, killing one man and fatally injuring another. The towboat was going down the stream with its loaded barges, and when opposite the Edgar Thompson Steel Works at Braddock the accident occurred, and in a very short time the boat was burned to the water's edge. The accompanying illustration is of the wreck of this towboat, and shows barges on either side which were used in raising the wrecked vessel. The *Ailes* was a comparatively new boat, belonging to the Monongahela River Consolidated Coal and Coke Company, and was used for towing coal barges about Pittsburg. She was 135 feet long, 25 feet beam and 4 1-2 feet deep.

PITTSBURG TOWBOAT JOHN W. AILES, WRECKED BY BOILER EXPLOSION
(Photo. by Chautauqua Photographic Co., Pittsburg, Pa.)

CARE AND MANAGEMENT OF THE MARINE GASOLINE ENGINE—I.

BY E. W. ROBERTS.

Gasoline engines were first employed as a motive power for boats the latter part of the eighties. Since then they have gradually increased in popularity until now boats driven by gasoline engines are to be found in nearly every quarter of the globe. While their principal use is for pleasure craft, quite a number are employed for business boats, such as oyster dredges, tugs, small excursion boats, and even in the life saving service. It is the intention of the writer, in the present series of articles, to give the reader some practical hints in regard to the care and management of these engines, point out the troubles that are most likely to occur and the remedies which apply in each case. As it is necessary in the care of any machine to understand the principles upon which it operates, the writer will, for the benefit of the uninitiated, describe as briefly as possible what takes place in the gas engine.

TWO TYPES.

Two types of gas engines are in use for marine purposes, the four-cycle engine, in which the piston receives an impulse in each cylinder once in two revolutions of the crankshaft, and the two-cycle engine in which each piston receives an impulse at every revolu-

tion of the crankshaft. The latter has had its widest use for boat propulsion, and has been used but little for stationary purposes. The four-cycle engine, which has practically held the monopoly in the stationary field, is gradually being adopted by marine engine builders, especially for the larger powers. In the following explanation the engine will be considered as of the vertical type, since this is the only type commonly employed for marine purposes.

FOUR-CYCLE TYPE.

In the four-cycle engine four strokes of the piston are required to complete the series of operations necessary to produce one impulse. In the first stroke of the cycle the piston is traveling downward, and a valve is opened which communicates with the atmosphere and the gasoline supply, drawing into the cylinder an explosive mixture of gasoline vapor and air. On the following upstroke of the piston, the inlet valve is closed and the charge of fuel and air is confined within the cylinder, being compressed into the space between the end of the piston and the cylinder head, called the compression space or clearance. Just before the piston reaches the end of this stroke, the charge is ignited by an electric spark or other means, the ensuing rapid rise of pressure or explosion reaching a point from four to four and one-half times the pressure of compression. The piston then starts on its next downward stroke, expanding the burned gases and giving an impulse to the piston. Just before the expansion stroke is completed and about one-tenth of the stroke from the end, the exhaust valve opens, the burned gases are free to escape to the atmosphere, and the next upstroke of the piston expels them almost entirely from the cylinder. The exhaust valve closes just at the end of this stroke and the inlet valve opens, a new charge is drawn in and the cycle is repeated.

TWO-CYCLE TYPE.

In the two-cycle engine, practically the same course of events is passed through with, however the elimination of the exhaust stroke and the suction stroke of the four-cycle engine. In this type of engine the crank is entirely inclosed, so that on the up stroke of the piston a vacuum is produced in the crankcase into which the charge is drawn as in the suction stroke of the four-cycle engine. On the down stroke of the piston the charge is compressed to from two to six lbs. per square inch, and just before the piston reaches the bottom of the stroke it uncovers a port leading to the crankcase, the charge rushes upward into the cylinder of the engine striking a projection on the piston, which deflects it to the top of the cylinder. On the following up stroke of the piston this charge is compressed into the clearance space, and at the same time a fresh charge is being drawn into the crankcase. Ignition and expansion follow, and just before the inlet port from the crankcase is opened the piston uncovers an exhaust port on the opposite side of the cylinder, through which the exhaust escapes to the atmosphere while the incoming fresh charge assists in clearing the cylinder of the burned gases.

To the reader who is unable to understand the principles of the gas engine from the above description, the writer would suggest that he secure a textbook on this subject, of which there are several in print. He is advised to familiarize himself thoroughly with the above, as it will many times assist him in locating the causes of trouble where otherwise he would be most likely to stumble along in the dark, resorting to guesswork, which is always slow and quite often futile.

EFFICIENT WORKING.

In the engine proper, aside from its accessories, there are several points bearing upon efficient working that it would be well to bear in mind. In the first place the charge of gasoline and air should have the fuel in proper proportion to the air. If there is too little gasoline the impulse will be weak, and sometimes no ignition will take place, while frequently in a two-cycle engine a mixture poor in fuel will often take fire in the crankcase, retarding the piston and slowing the engine. If there is too much gasoline the engine will act sluggishly, and usually much of the gasoline will pass out of the exhaust unconsumed. This may quite frequently be detected by the engine acting as if it were tired, being sluggish and apparently having a drag upon it. Again, if the operator's face is held near the exhaust the unconsumed vapor will produce a sharp pain in his eyes, as well as giving forth an intensely strong odor of gasoline.

The opening of the inlet pipes and the valve should be sufficiently large to allow the charge to be drawn in without the pressure in the cylinder falling more than a pound or two below that of the atmosphere. The forming of an excessive vacuum during the suction stroke, called wire drawing, is to be avoided, as it prevents the engine from getting a full charge and results in a consequent loss of power.

The piston of the engine should be tight in order to bring the compression up to the required point, which is between 75 and 85 pounds for a gasoline engine, the latter pressure being practically the limit for gasoline. As the maximum pressure is in direct proportion to the compression pressure, any falling off in the compression will result in a lower maximum pressure, and the expanding charge will give a consequently less powerful impulse to the piston, resulting in a falling off of power.

POINT OF IGNITION.

Another item of importance is that ignition should take place at the proper time in the compression stroke. There is a definite time required after the spark takes place until the mixture is entirely in flame and a maximum pressure attained. It is generally conceded by experts that the maximum pressure should occur as nearly as possible at the beginning of the expansion stroke to get the most powerful impulse. This is quite an important feature in the operation of the gas engine, since, if ignition is too early, it will cause maximum pressure to occur before the end of the stroke, retarding the piston and lowering the power. Again, if the spark occurs too late, the average pressure to the piston is decreased with the same result as with too early ignition. Premature ignitions quite often result in stopping the engine entirely, but a tardy ignition usually results simply in decreasing the power.

With the same fuel mixture, meaning both the quality of the fuel and its proportion to the air, and under like conditions of compression pressure and temperature, the period of inflammation is precisely the same no matter what the speed of the piston. By the period of inflammation is meant the time from the moment the spark

occurs until the flame has reached every part of the charge. It will thus be seen that as the speed of the engine increases it is necessary to advance the point in the stroke at which the spark occurs in order to get complete inflammation and maximum pressure at the beginning of the expansion stroke. If the ignition is too early it will often make it difficult to start the engine, throwing the piston back and occasionally throwing the engine in the wrong direction. It is generally desirable to use a device for changing the lead of the spark, advancing it as the speed increases, in order that the engine may secure the greatest possible impulse at any speed. When the ignition occurs before the end of the compression stroke the igniter is said to have positive lead, usually called simply lead; and when the spark occurs after the beginning of the expansion stroke the igniter is said to have negative lead. A variable lead igniter is one in which the time of ignition may be changed either by an automatic device or by the hand of the operator.

On the smaller engines the lead is usually made constant, and hence a quick turn of the flywheel is required in starting them, or else the engine would start backwards. In these engines it is usually the custom to make the lead a compromise between that required for the engine running at normal speed and no lead at all. This is done in order that the engine may be started easily and also that it may have very nearly its full power when running at normal speed. An igniter with too much lead will cause excessive racing when the engine has no load, and when the load is applied it will not respond promptly to the throttle, as, when the throttle is opened wide, it will be very slow in reaching its normal speed. Premature ignitions are usually indicated by a thumping in the engine, although this may be produced by several other causes, which will be discussed later.

EXHAUST.

The exhaust valve should open sufficiently early in the stroke to allow the pressure in the cylinder to reach that of the atmosphere by the time the exhaust stroke is completed. For engines running at or near a piston speed of 600 feet per minute the valve is opened when about 90 per cent. of the stroke is completed. As the speed increases the exhaust valve should open earlier, and as the speed of the engine is decreased it should open later in order to get the least back pressure and yet not lose any of the thrust due to relieving the pressure too early. The exhaust passages, including the muffler, should be reasonably free from resistance to the gases, otherwise there will be back pressure retarding their escape and also a back pressure on the cylinder retarding the piston.

Of course the best way to discover what is going on inside of a gas engine cylinder is to take an indicator card and study the diagram; but as this is usually out of the question for the operator, the best way is to watch the engine and see that the valves are in proper time by noting their position when the engine seems to give the best results. The inlet valve should open just at the beginning, and close at the end or immediately after the end of the suction stroke. The exhaust valve should invariably close just as the exhaust stroke is completed. Both valves should be tight at all times, and if they should leak they should be reground to their seats with pumice stone and oil, but at no time should emery be used. In case pumice stone is difficult to obtain, the dust from a grindstone will be found a satisfactory substitute.

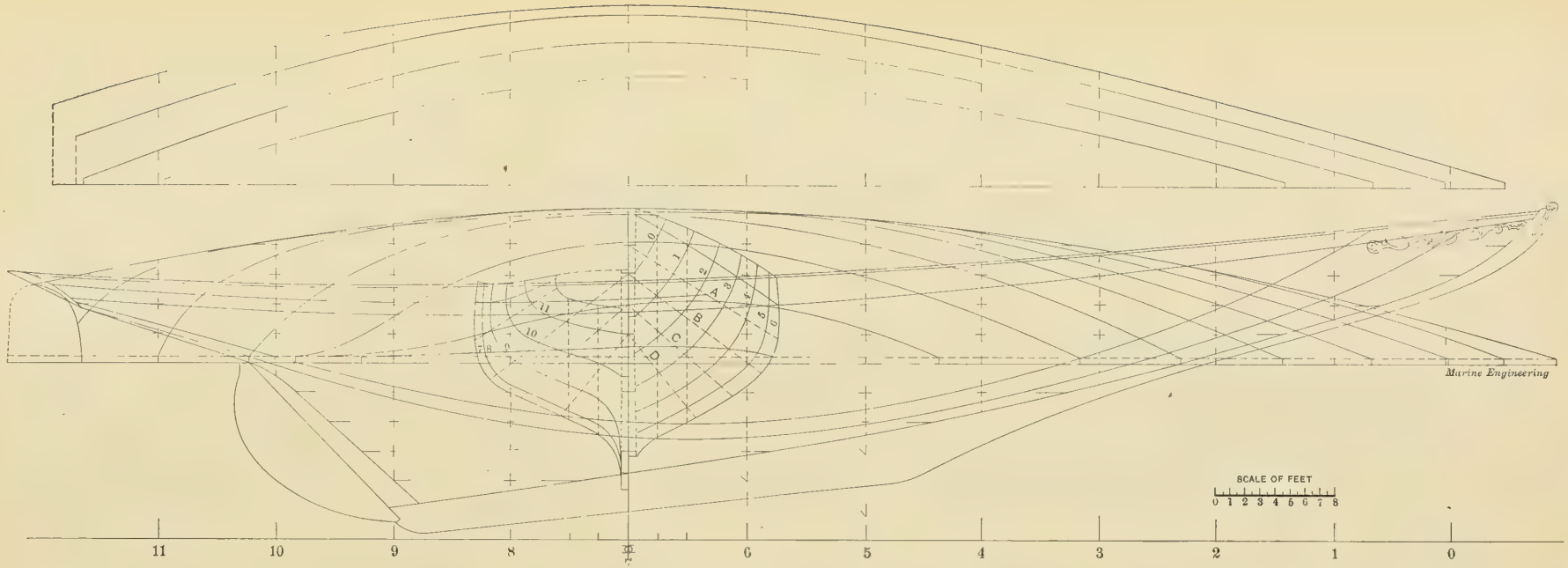
THE KNOCKABOUT FISHERMEN.

The Gloucester fishermen have from time past always been on the lookout for some improvement on the model or construction of their craft which would make them better as regards speed, seaworthiness, or comfort. Hemp standing rigging, stone ballast, and the old fashion model have gradually given place to steel rigging, iron ballast, and the most up-to-date model, until the Gloucester schooners of to-day have the appearance of a yacht more than of a schooner which has to be able to ride out gales on the banks that send all but the largest ocean steamers to port for shelter.

The fishermen have for a long time kept their eye on the new style of yacht called the knockabout, and one or two half successful imitations have been built, but at last Capt. Wm. Thomas decided that he would try a knockabout fisherman pure and simple, and commissioned Capt. Thomas McManus, from whose drawings have been built a number of successful up-to-date craft, to get out the lines for a fisherman which was to have no bowsprit, the overhang forward being carried out in excess to take its place. This he hoped would not only give the craft greater speed on account of making longer and easier lines, but it would overcome the danger of the sailors going out on the bowsprit to furl the jibs, which in a gale of wind, especially in the winter time when everything is slippery with ice, is a very dangerous undertaking.

The new craft, the *Helen B. Thomas*, whose lines and sail plan are published herewith, is the first craft to successfully carry out the knockabout idea. Her success can thus far be judged only from her trial trip, which occurred recently in a very heavy breeze, so heavy that at times she had all she wanted with a single reefed mainsail and two jibs. Even under these conditions, which were such as few new crafts would have picked for a trial trip, she behaved admirably, showing that while she held most of the good qualities of the knockabout she had entirely done away with that bad quality, excessive pounding; for although the sea was very steep and she threw considerable water, there was no shock as she struck the waves, and she did not lose her headway, but kept right on without seeming to mind the sea in the least.

As regards the speed there were one or two larger schooners that started from Gloucester at about the same time as the new craft, and although it was a dead beat all the way there, she showed her heels to them all, and when she ran into Boston harbor, the nearest was fully two or three miles astern. On the way it was noticed that she obeyed her wheel very quickly, and it was decided to try and see how quick she could tack. It need hardly be mentioned that designer, owner, crew and guests were very much surprised when it was found that she tacked from full to full under those unfavorable conditions in 23 seconds. After getting way on it was tried a number of times again, which showed that



LINES OF KNOCKABOUT FISHERMAN HELEN B. THOMAS.

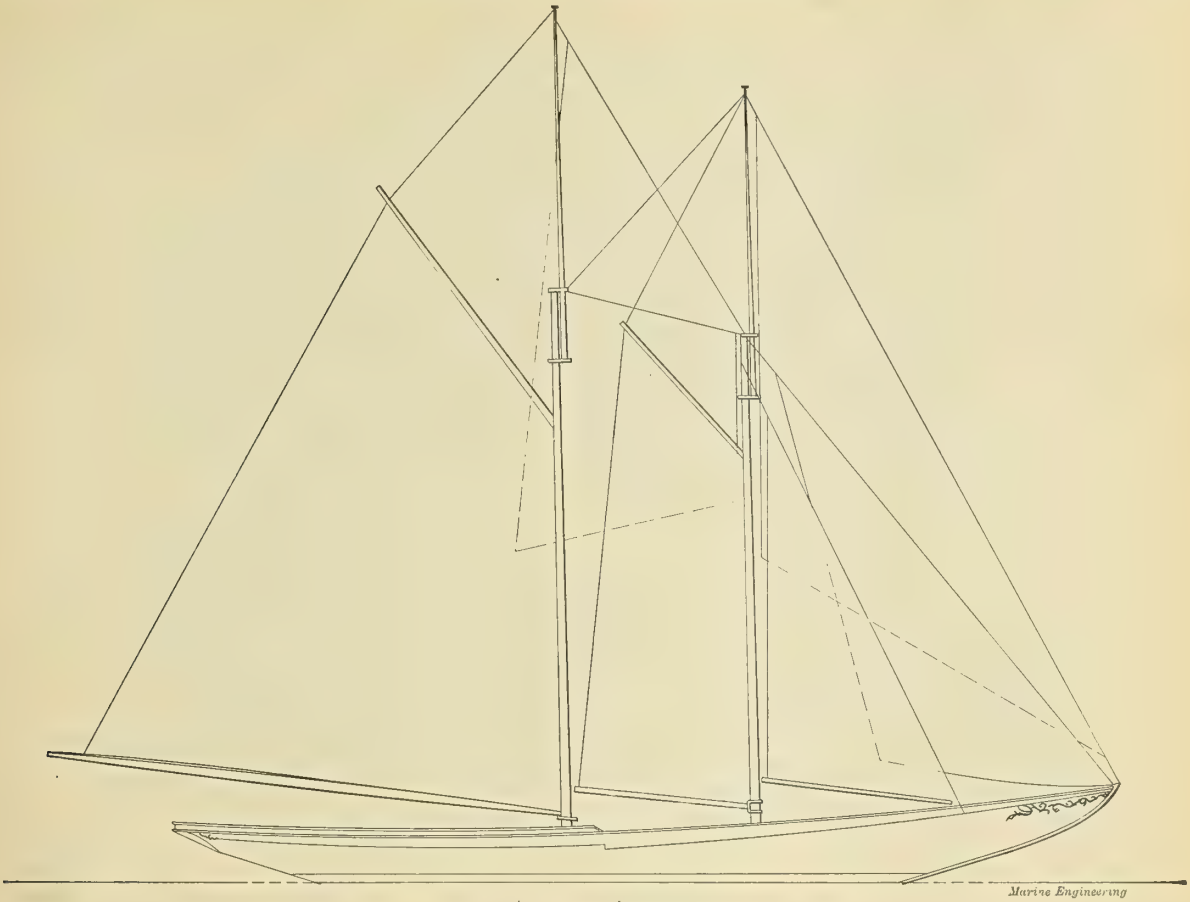
she could tack from full to full in from 20 to 25 seconds, which, needless to say, is wonderfully quick time, for the *Columbia* and *Shamrock* took from 25 to 30 seconds, but it only goes to show how near the crack yachts are the Gloucester fishermen of to-day.

The *Helen B. Thomas* is 106 feet 7 inches over all, 66 feet L. W. L., 24 feet 9 inches overhang forward, 15 feet 10 inches overhang aft, 21 feet 6 inches beam, and 14 feet draft, 9 feet 6 inches depth of hold. The foremast is 40 feet 6 inches inside the stem head. She was built at Oxner and Story's yard in Essex, Mass., and is constructed after the manner of all fishermen. Her keel is 12 inches sided white oak. The frames are molded 7½ inches at the heel, and 5½ inches at the head, sided 6 inches and spaced about 18 inches. The planking is 2½ inches white oak and fastened with oak treenails. The main deck beams are 8 by 8 inches oak with a crown of about 4½ inches spaced about 5 feet. The half beams are 6 by 6 inches oak, one between each main beam. The break in the deck comes on the beam forward of the mainmast. The deck is 3 inches pine in narrow strips caulked and the seams run with marine glue. She carries about 60 tons of iron ballast and besides this on her out trip she will have 10 or 12 tons of ice which answers for so much more ballast. Returning from her trip, of course, she will be loaded with fish.

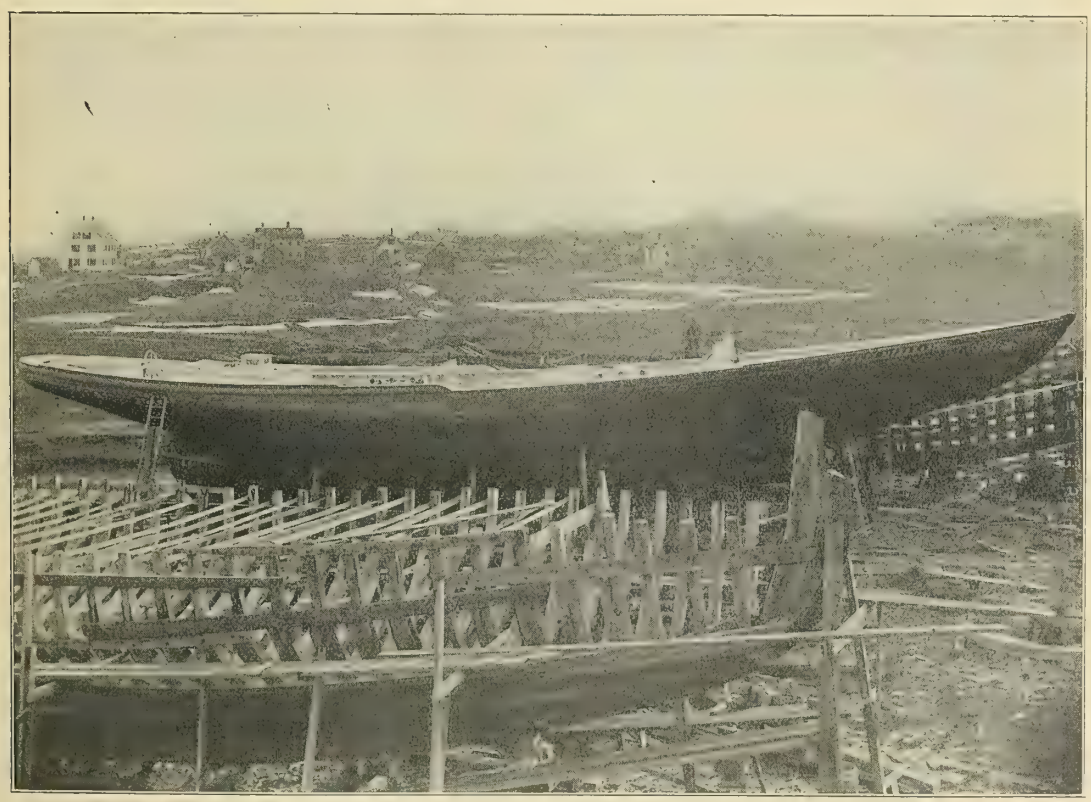
Her cabin is cypress finished bright. The forecastle is pine and whitewood. The cabin is about 11 feet 6 inches long and extends the whole width of the boat. It contains four berths with lockers at the after end for stowing away old sails, ropes, etc. The forecastle extends from the stem to about 12 feet aft the foremast and contains, besides the stove and necessary lockers for cooking utensils, 15 berths in two tiers, 8 on the port side and 7 on the starboard.

This schooner, as well as most of the others that are built in this vicinity, was completely fitted out by E. L. Rowe and Son, who take the schooner from the builders' hands and fit her with sails, rigging, cooking utensils, nautical instruments, and, in fact, everything ready to go to sea. From their books we get the following sizes of rigging and weight of sail, material, etc.: Fore and main rigging three shrouds on each side 2¾-inch iron; jib stay 2¾-inch iron; fore stay 3-inch iron; balloon jib stay 1½-inch steel; fore and main topmast backstays 1¾-inch iron; preventer backstays, 1½-inch iron; spring stay 2¾-inch iron; main topmast stay and counter stay 1¾-inch iron, and main and fore back stays 1¾-inch iron.

For the weight of sail material we get: Mainsail and outer jib, No. 2; foresail, fore staysail and riding sail, No. 1; main and fore topsail, No. 8; balloon jib, 6 ounce; staysail, 10 ounce.



SAIL PLAN OF THE HELEN B. THOMAS.



THE KNOCKABOUT FISHERMAN HELEN B. THOMAS READY FOR LAUNCHING.

Torpedo Boat Destroyers.

In view of the distrust that appears to exist in regard to the structural strength of torpedo boat destroyers and the reliability of the machinery, the following particulars furnished by Mr. Yarrow, bearing upon the structural strength and speeds attained by the destroyers built at his yard may be of interest. Eight torpedo boat destroyers, 220 feet long, having a speed of 31 knots, within recent years have been completed by Yarrow and Company. Six of these have steamed out to Japan, where they were in constant service between China and Japan during the recent Eastern crisis. They have not shown any symptoms of structural weakness. One point that does not seem to be sufficiently appreciated is that the safety of lightly constructed vessels, such as destroyers, is dependent to a very large extent upon the elasticity of the vessel when encountering rough weather, and said elasticity must be as uniform as it is possible to make it, otherwise the bending strain will be concentrated at certain points, overloading the metal, which ultimately will give away. The study of the structural strength of vessels when considered as a girder with a proper proportionment of material to resist the bending and hogging moments, should be very carefully considered by naval constructors.

Considering the extreme delays in this country in completing the official trial trips of destroyers and torpedo boats, it is interesting to note in the following table of Japanese destroyers built by the above mentioned company the interval between the date of launching and the date of the official trial.

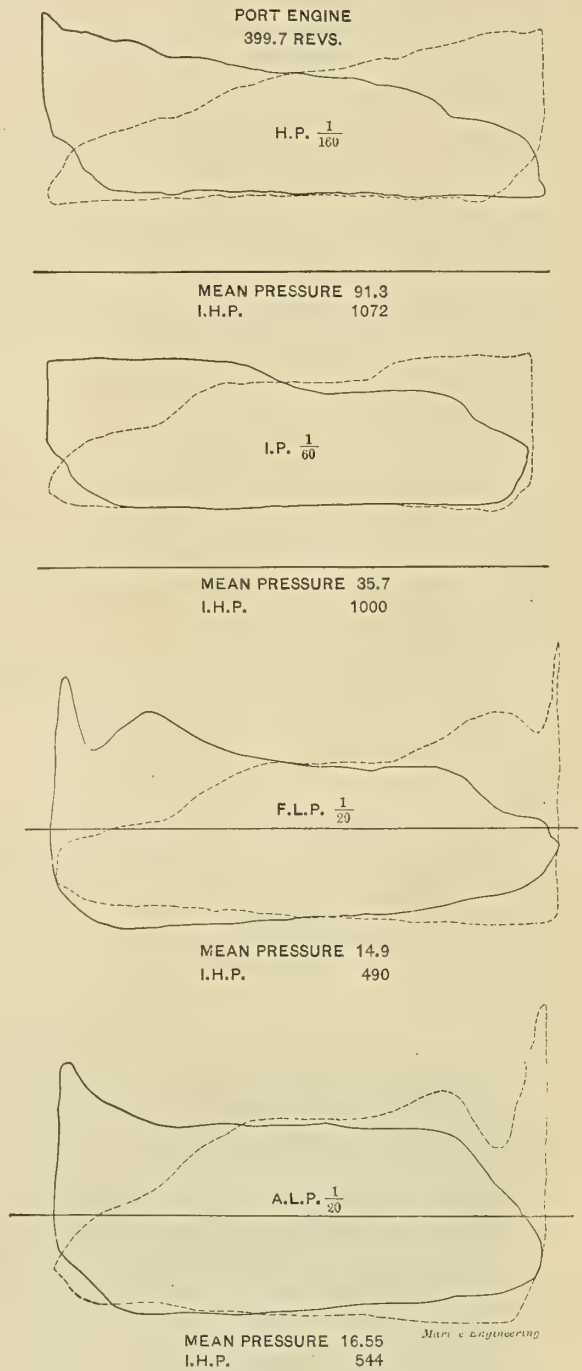
In each case the trial consisted of a run of three hours duration, with a load of 35 tons in the case of the first six vessels, and 40 tons on the two last built. The accompanying illustration is of the engine of the *Kasumi*, which is of the four-cylinder triple-expansion type. The diameters of the cylinders are, H. P. 20 1-2 inches, I. P. 31 1-2 inches and the two L. P. 34 inches. The common stroke is 18 inches.

The lightness and compactness of the design are evident. They are balanced according to the Yarrow-Schlick-Tweedy system with the low pressure cylinders at the ends and the high and intermediate cylinders between. The indicator diagrams of the port engines of the *Kasumi* on her official trial show an even distribution of power and very good adjustment.

The consumption of fuel per horse power on these destroyers varies from 2 to 1 1-4 pounds of coal per I. H. P. per hour.

Name of Vessel.	Date of Launching.	Date of official trial.	Interval between date of launch and date of official trial.	Speed in knots.
Ikadsuchi....	Nov. 15, 1898	Dec. 23, 1898	38 days	31.32
Inadsuma....	Jan. 28, 1899	Mch. 8, 1899	39 "	31.03
Akebono....	Apr. 25, 1899	May 4, 1899	9 "	31.08
Sazanami....	July 8, 1899	July 24, 1899	12 "	31.38
Oboro.....	Oct. 5, 1899	Oct. 14, 1899	9 "	31.26
Niji	Dec. 16, 1899	Dec. 21, 1899	5 "	31.16
Akatsuki.....	Nov. 13, 1901	Nov. 21, 1901	8 "	31.12
Kasumi.....	Jan. 23, 1902	Jan. 29, 1902	6 "	31.24

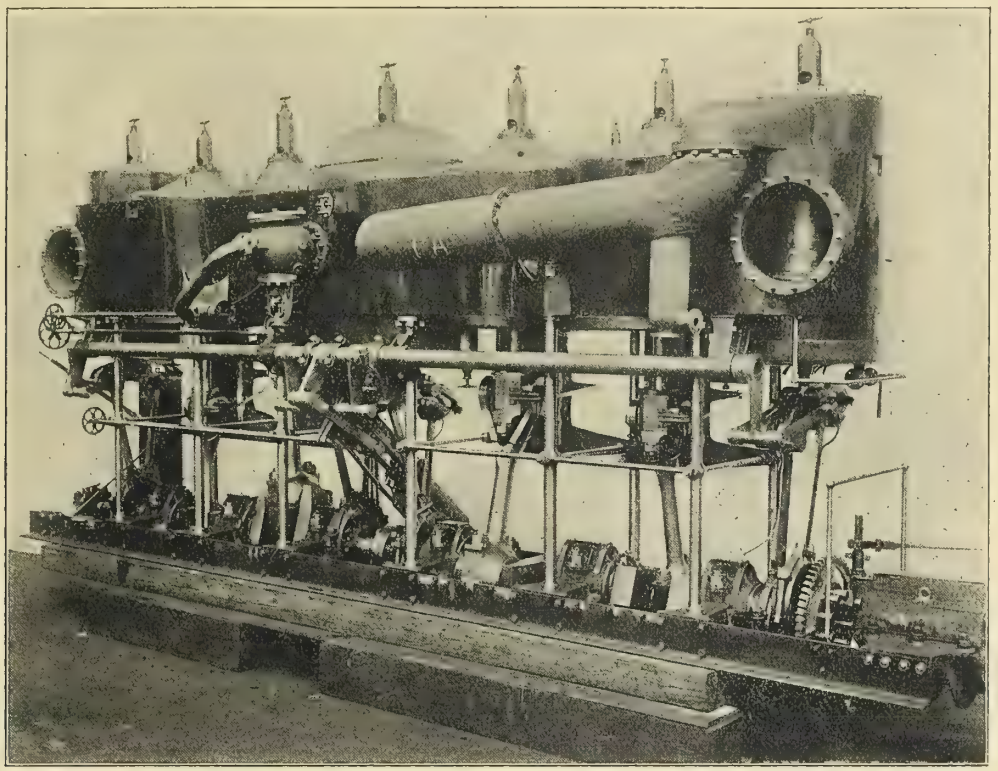
There are four boilers of the Yarrow express water tube type with side tubes, each with a capacity of 1,600 H. P. With water and fittings each boiler weighed 18 tons. Fore and after coal bunkers are located at the sides of the vessel, with a capacity of 90 tons, which gives a steaming radius at a slow speed of 3,900 nautical miles.



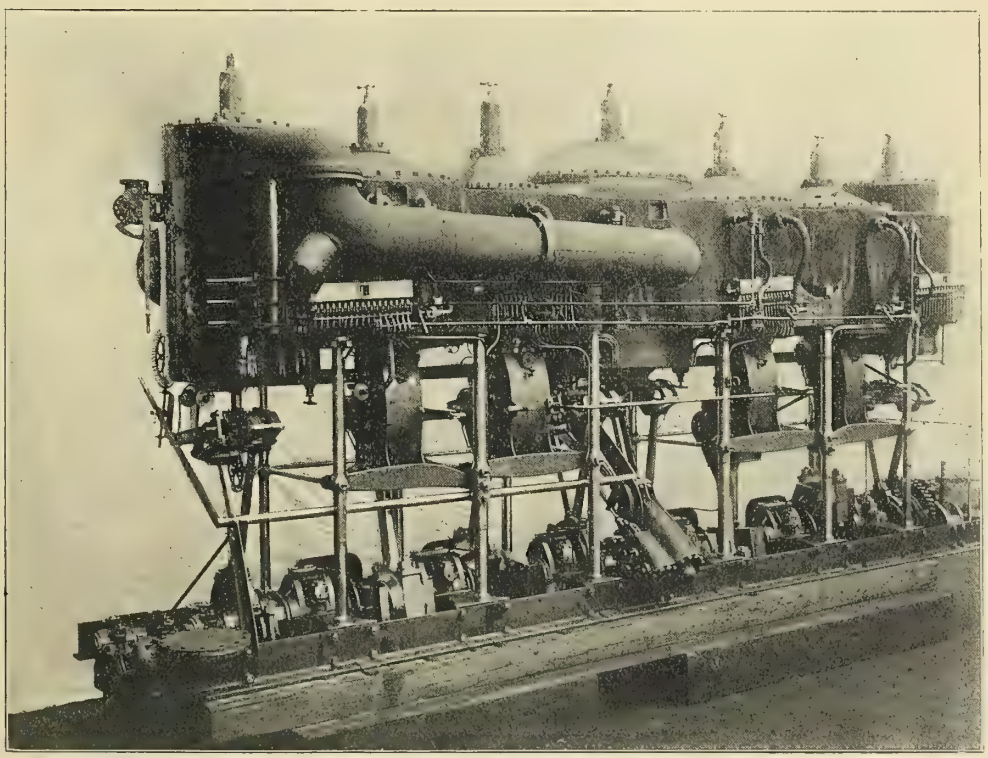
INDICATOR CARDS ON THE PORT ENGINE OF THE KASUMI, COLLECTIVE I. H. P. 3106.

The general dimensions of this vessel are the same as her sister destroyers, viz.: Length, 220 feet 3 inches; breadth, 20 feet 6 inches; draft, 5 feet; displacement, 311 tons.

The armament consists of two 12-pounder and six 5-pounder rapid firing guns and two 18-inch torpedo tubes.



FRONT VIEW OF THE STARBOARD ENGINE OF THE KASUMI.



REAR VIEW OF THE STARBOARD ENGINE OF THE JAPANESE TORPEDO BOAT DESTROYER KASUMI.

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Notice to Advertisers.

Changes to be made in copy, or in orders for advertisements, must be in our hands not later than the 15th of the month, to insure the carrying out of such instructions in the issue of the month following.

THE great steamship combination has during the past month attracted the keenest attention from the entire commercial world. Its development as a natural result of the economic and industrial movements of the present day is, however, readily traced. Intercommunication between man and his fellow is a distinguishing feature of our modern civilization; it is one of the great fundamental facts which differentiate the civilization of the present day from that of 500 or even 100 years ago. Now one of the movements of the age, beginning in marked degree some 15 to 20 years ago, is the centralization and massing of these means of intercommunication under a small number of directive centers. The railroads and the steamship lines are the two great branches of the modern development of ways and means for transportation and communication. This centralization and unification has gone on in the administration of our railroads until it has reached the point where a few closely related interests control the larger part of our great railroad systems. It is then the simplest and most natural thing in the world that the same general interests should seek to control the other great arm of the carrying business, the steamship lines. Railroads by themselves are limited to the territory through which they can lay their rails. The ocean, however, is free; the ship needs no rails and follows no beaten path. With steamship connection, therefore, the railroad is able virtually to extend its lines across the seas and to the uttermost parts of the civilized world. The railroad lines and the steamship lines have, therefore, every reason to make common cause under such a centralized administration as shall insure unity of purpose and efficient direction with minimum expense. We take it that the present shipping combine is nothing more than the working out to its logical conclusion of this general movement toward centralization in the carrying trades which has recently been coming into such great prominence.

As to the results for the public it is, perhaps, too early to attempt any discussion. We are promised increased and better service for mails, passengers and freight. As to the effect on shipbuilding and shipping interests in general but little can be said in advance of more definite information regarding the details of the scheme, and the plans regarding construction, repairs, etc.

Until we have further information as to details we should, perhaps, suspend judgment as to these various points, and in the meantime watch with interest the development of this latest manifestation of the spirit of the age.

ON another page of the present issue we print a description of the equipment of the canal of the hydraulic laboratory of Cornell University for experimental research relating to the resistance and propulsion of ships. The general installation and equipment of this laboratory have been proceeding for the past three or four years, but it is only within the past year that a start could be made upon its equipment for research in the directions above noted. From the description of the equipment, as now installed, it will be seen that the present line of investigation has chief reference to the performance of screw propellers. In the whole field of Marine Engineering and Naval Architecture there is, perhaps, no single problem which is more complex or which depends upon a larger number of varying conditions interacting in marvelously intricate ways upon the final performance.

This has long been a favorite field for the mathematician and the theorist, though it must be ad-

mitted that their work has had but small influence upon the practical design of screw propellers for conditions which arise in ordinary practice. Such design always has, and from the nature of the case, always must rest upon experience either with full-sized propellers or as drawn from experimental research with smaller models. It may be fairly said that in the present condition of our knowledge regarding the screw propeller, what is needed is a larger storehouse of facts rather than further attempts at theoretical discussion. Without such facts all theory will be fruitless; with them it will be of aid in their interpretation and intelligent use.

As to the reality of this need, no detailed discussion is required. It is true that for the average case of marine design, where the conditions are easily fulfilled and where existing experience is wisely used, there is no difficulty in designing a propeller which shall efficiently fulfill the conditions imposed. Where these conditions, however, are somewhat extreme, or where it is desired to depart somewhat from the broad path of average practice, need is immediately felt for more exact information. An illustration of this is found in the United States torpedo boats and destroyers now under construction and on trial. In many cases these have been fitted over and again with propellers of varying characteristics in the hope of bettering the performance in one way or another. With adequate information such groping in the dark would be unnecessary.

It is understood that the purpose of the equipment above referred to has especial reference to the further detailed investigation of screw propellers in the hope that this margin of uncertainty may be somewhat reduced. It is understood, furthermore, that the facilities here available for the investigation of such propellers are intended for the use of the engineering profession at large, and especially for the shipbuilders of the country. With competition ever increasing in keenness there is a corresponding need for accuracy and certainty in all features of design, and it often happens that the margin of profit may be largely or even entirely wiped out by some failure to realize on the first trial the full possibilities inherent in the conditions imposed. This equipment and the facilities here available are intended as an aid to the American shipbuilder in the elimination of some of the uncertainties which thus arise in the practice of his art.

Those who may be interested in the use of such facilities for research should communicate with Professor W. F. Durand, of Cornell University, who has charge of this work and from whom details regarding facilities for investigation in this field of engineering practice may be learned.

IN spite of the oft-made charge that we are giving an undue amount of time and energy to the various activities making up the strenuous life of the average American, it is, nevertheless, a fact that an increasing amount of time is devoted from year to year to the various means of recreation and amusement. We are apt to pursue these means of recreation, however, in the same spirit in which we pursue the business aim, and it is perhaps for this reason that the automobile and motor launch take so prominent a part in providing for diversion from business cares. Either of these, however, requires some skill and some small acquaintance with engineering matters for its proper operation and care, while from the very nature of the case many are operated by amateurs in engineering matters. It is, therefore, desirable in the highest degree that machinery of this type should be reduced to its simplest form and that its care and operation should be made to depend upon the smallest number of simple manipulations and adjustments.

It is a fact, however, that motors of the gasoline type can hardly yet be considered as having reached a final stage of development. In many ways they involve peculiar features and often present puzzling problems to the amateur engineer. The season for the motor launch is now at hand and everything indicates an increasing use of this type of boat for the coming summer months. It is for these reasons that we have been at pains to provide for readers of MARINE ENGINEERING as much practical information as possible relating to the operation and care of such boats.

Articles treating this subject will be found elsewhere in the present issue. Their authors will be recognized as men who have had wide experience in this field and who are qualified to speak with authority on such subjects. It is hoped that these articles, together with other similar matter which will be provided, may prove of aid to those interested in such boats, and especially to the large class of those who have not been trained as engineers, but who take an intelligent interest in the principles relating to the operation and care of machinery of this type.

MISHAPS AND REPAIRS.

An Apprentice's First Experience.

Several years ago I was an apprentice at a shipyard on the Tyne, and was started in the drafting room. The chief-draftsman gave me the simplest kind of work, and mostly tracing at that, and, after a few months, I began to feel as if I was not finding the proper opportunity to get ahead. So one day when I was telling my troubles to the chief-engineer of one of the ships which was at the yard for engine repairs, he advised me to try to get some sea experience, to which I enthusiastically agreed, and he said he would do what he could to help me.

The new freight ship *N*——— was about to leave for Marseilles, and through my friend's efforts I was taken along as a donkey boilerman. On a ship where there are three engineers besides the chief, a donkey boilerman, who ranks next to the third-assistant engineer, is on the first-assistant's watch, and is at the beck and call of his superiors both on and off watch. Before we had been out very long the crank pits became filled up with the water which was used to cool the bearings which had been running hot. Chains are run through the limber holes in the fore and afters of the engine foundation, so that when these holes are clogged up all that is generally necessary is to pull the chain from one side to the other. However, this would not clear the limber hole, and every time the crank came around a shower of water was sent against the back of the engine, so the first-assistant told me I would have to clear it out.

Anyone who has been in an engine room at sea knows what a filthy hole the crank pit becomes with oil and grease. The only thing for me to do was to crawl in through the side under the engine bed plate, in a space just large enough to wriggle through, and reach into the pit, and pull out the waste which some careless oiler had thrown away. At the time, as I lay on my back, I was in grease and water which came almost up to my mouth.

But I only had to do this once on the voyage. The boilers gave us all kinds of trouble and no less than sixteen tubes gave out on that short trip, and I was called upon sixteen times to crawl through the furnace into the combustion chamber and put the washer and nut on the bolt which was passed through the tube from the front. The steam was not reduced, however, on the boiler, only the fire and grate bars were removed and the bridge wall covered with sacks of sand. Over these I crawled, feeling like a boiled lobster, and I never worked so fast on any other job as while putting the washer and nut onto the bolt and getting back again.

I did not realize at the time how much valuable experience I was gathering, but was glad indeed to get back to the yard and continue in the drafting room.

The plan of promotion for apprentices from one department to the other was really as rapid as advisable. Before many months I had passed through all the departments of the machine shop, had some experience in fitting and was again back in the drafting room as a full-fledged draftsman. I believe that the English apprentice system is a decidedly good thing for the men, as it compels the apprentice to gather experience in several branches before he can become a full-fledged mechanic or artisan in other branches. In my opinion it is absolutely necessary for a first-class draftsman to have some experience in the shops, and, if all of them could have such experience, we should find more practical designing. W.

Repair of a Winch for a Traveling Crane.

The frame of the winch was broken as shown by the line AB in the figure. The following is the description of the method of repair adopted. The following material was required:

(1) A piece of wrought steel C.

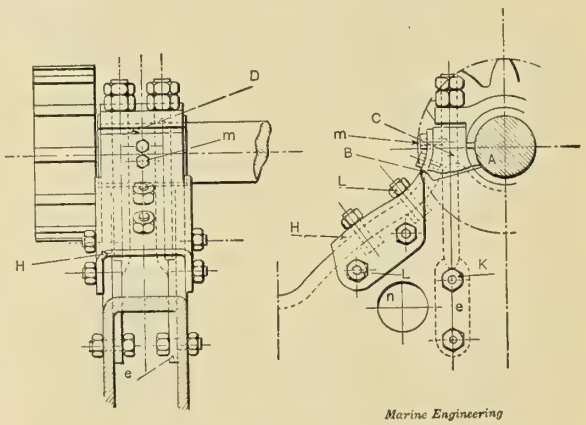
(2) Two bolts D with flat part at *e*, bolted to the frame as shown.

(3) A piece of one-half inch steel plate H, bolted with the piece C.

The operations were carried out as follows:

(1) Clean off the fracture AB in a right line so as to have a little recess at B.

(2) Form the piece C, fit it to the prepared surface of the fracture and mark the holes for the two bolts D. Then dismount the piece C and drill the holes as marked.



ILLUSTRATING REPAIRS MADE TO A WINCH.

(3) Make and fit the two bolts D, securing them by the small bolts K.

(4) Fit the piece C in its true position relative to the bolts D.

(5) Make and fit in place the piece of steel plate H.

(6) Mark and drill the holes in this piece for bolts L and for screws *m*.

(7) Fit the piece H and mark the holes on the frame and on piece C and then dismount it.

(8) Drill the holes for bolts L, then drill and tap the holes for screws *m*.

(9) Fit the piece H. Tighten the bolts L and screws *m*. These bolts were introduced by the hole *n* in the frame.

(10) Fit the shaft and upper part of the bearing.

This repair was made eight or nine years ago, and the winch is still in regular service.

A Boiler Repair.

The following accident and the repairs made to the boiler took place in the Indian Ocean, aboard a British tramp steamer of about 2,200 tons, the ship having a triple expansion engine of 1,800 horse power, and 2 single end Scotch boilers, each boiler having 3 furnaces

fitted with Adamson rings. The steam pressure carried was 120 pounds per square inch. Owing to the fact that the high-pressure cylinder was fitted with a double-ported slide valve without a relief frame, large quantities of cylinder oil were used to facilitate the working of this valve, for without this liberal use of oil the valve would grunt and the engines would vibrate in such a fashion so as to make the ship tremble from stem to stern. The vessel was also fitted with an Edminston filter, which was in the feed line for the purpose of removing the oil from the feed water, but all these filters are fitted with by-pass valves which allow the feed water to pass to the boilers without going through the filter, and this particular one was not an exception.

The chief engineer was one of the old fashioned kind who did not believe in new-fangled additions to the engine-room; and so, after the cloth in the filter had become choked with grease, thus increasing the pressure on the feed pump plunger, the worthy chief, instead of renewing the cloth toweling, simply opened the by-pass valves, and so the oil was allowed to enter the boilers with the feed-water.

All went well for several days, until about five days before the welcome sight of land was to be expected, when the third engineer then on watch, noticed that the crown sheet of the middle furnace was coming down. He immediately closed the fire door, and not a moment too soon, for the furnace kept coming down until it touched the grate bars, and then the furnace opened up, the hot water coming through the crack. The engineer on watch immediately sent up for the chief engineer, in the meantime closing the stop valve on the boiler and lifting the escape valves, putting on the feed and drawing the other two fires.

The boiler being disconnected and all the fires being out, the feed was shut off and the boiler blown down. Men were sent into the boiler after it was comparatively cool, and the oil washed off the other two furnaces, but the low furnace was in bad shape, having opened out for its whole length. This furnace was beyond repair, but the chief was a resourceful man, and decided to put this boiler in commission again if possible. Luckily the ship had a cargo of cement, and taking six barrels of this stuff into the fire-room, the chief proceeded to show the younger men how to repair this boiler. The grate bars were taken out and a plate was put at the end of the furnace at the combustion chamber, and then the cement was put into this furnace right against the plate, filling the furnace up solid with cement, and at the front end another plate was fixed to hold the cement in position until it had hardened. The furnace was simply a mass of solid cement, and after waiting some time for this to harden, the boiler was filled up again with water, steam raised, and the vessel went ahead with five fires instead of six.

The cloth in the Edminston filter had in the meantime been renewed and the boilers were carefully watched for more furnaces coming down, but nothing further happened and the voyage was safely finished. On arriving at the Indian port the boilers were thoroughly cleaned, but no new furnace was put in, Lloyds inspector being satisfied to have the vessel return to England as she was, without making repairs to the boiler, and everyone who came aboard complimented the chief engineer upon his ingenuity. After this little accident great attention was paid to the oil-extractor, and the voyage ended without further mishap.

EX WHY ZEE.

Explosion of Boiler Pipe.

While I was in the engineer's force on board the British steamer ——, a very serious accident occurred in the main steam pipe while waiting in a South American port. Upon later investigation it appeared that the primary cause of the explosion was defective brazing, therefore, I send you this account, believing it to be of interest to your readers.

The pipe was 6 inches internal diameter, made of copper .22 inches thick with brazed lap joint. We were carrying 130 pounds steam pressure preparing to leave port, when suddenly the pipe ruptured along the seam for a length of 2 feet 6 inches opening at the center of rupture to 1 foot 6 inches. It was torn from the flange connecting it with the stop valve of the port boiler, thereby permitting steam from both boilers to escape. One man was scalded before we were able to draw the fire and close the stop valve and reduce the boiler pressure. We then found that the lap was only 5-8ths of an inch at the widest and in one place where the rupture probably started, the lap was only 1-4th of an inch in width and the outer edge of the same had wasted away in the process of brazing. The inside surface was heavily pitted, the copper plate being reduced in places to .1 inch in thickness. It was also found that there was not sufficient solder along the seam to make a joint.

We later examined all of the steam pipes and tested them under a water pressure of 250 pounds, which pressure developed many weak places in the various lines. These parts were brazed and patched so as to carry the steamer back to her home port, where entirely new piping was fitted.

J. A. N.

ENGINEERS' DICTIONARY, XXXVI.

Prime (to) or **Priming.** See under **Foaming.**

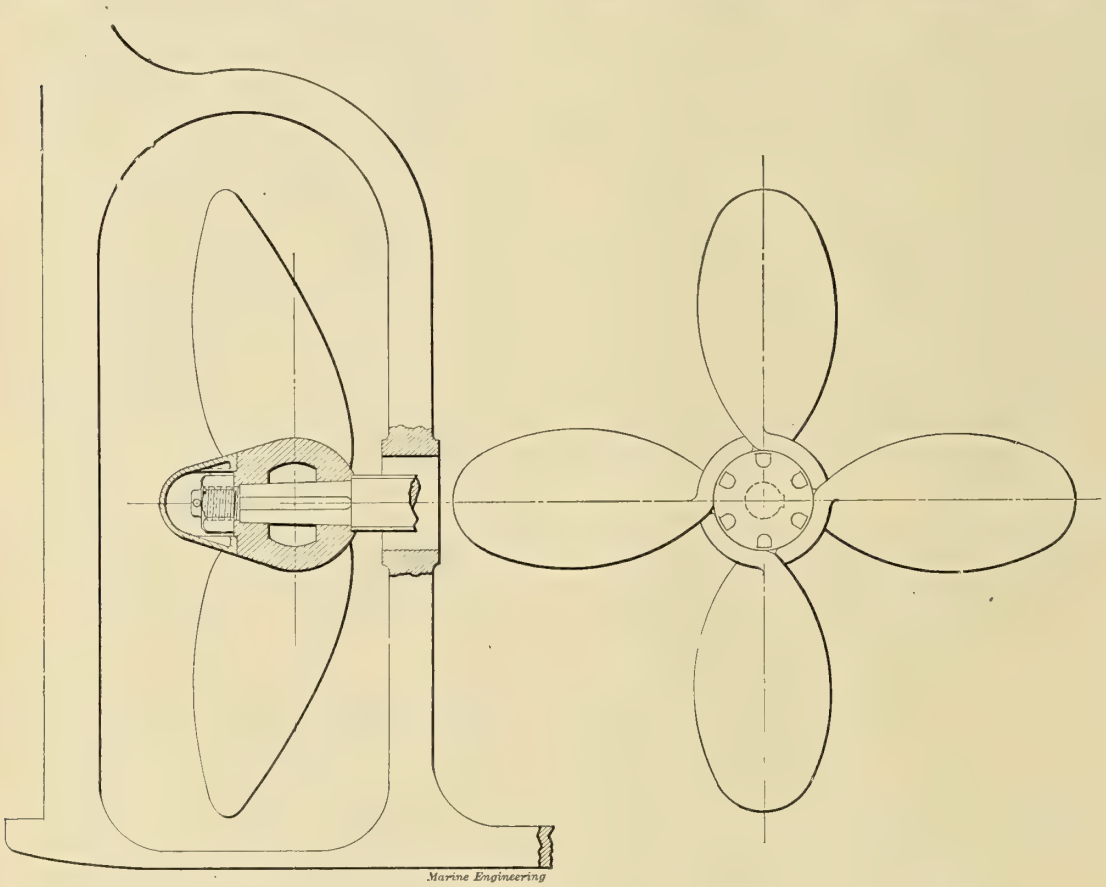
Propeller. An instrument for propelling a ship. The term usually implies, however, a screw or helicoidal propeller, as shown in the figure. Such a propeller may consist of two, three, four or even more blades attached to a hub which is carried on the propeller shaft, and by means of which the blades may receive a motion of continuous revolution in the water at the stern of the ship. The faces of the blades are parts of helicoidal surfaces; that is, surfaces similar to those forming the sides or flanks of an ordinary square thread on a bolt. It will be noted that the face is the *after* surface of the blade. The *back* or forward surface has such form as may result from the thickness given to the blade.

From the form of the blades it results that when the propeller is made to revolve the water about the stern of the ship is set in motion with an accelerated velocity directed aft. From the laws of mechanics it results that the propeller itself will be acted on by a force from the water resisting this acceleration and directed forward. This gives the propulsive thrust which is transmitted to the shaft, and then through the thrust bearing to the

ship itself. The number of blades in modern practice is usually three or four. When the propeller is of moderate or small size the blades are usually all made in one piece with the hub. When the propeller is large they are very frequently made separate with a flange or boss at the inner end by means of which they are secured to the hub with stud bolts and nuts.

If the blades are so placed that when driving the ship ahead, the propeller when viewed from aft looking forward turns with the hands of a watch, it is said to be *right-handed.* If it turns in the opposite direction it is said to be *left-handed.*

The *leading* and *following* edges of a blade are respectively the forward and after edges.



The *diameter* of a propeller is the diameter of the circle swept by the tips of the blades.

The *area* or *developed area* or *helicoidal area* of a blade is the actual surface of the driving face.

The *projected area* is the area of a projection of the blade on a transverse plane, or as viewed from aft looking forward.

The *disk area* is the area of the circle swept by the tips of the blades.

For the definition of *pitch* see under that head. If the pitch is the same for all parts of the blade the propeller is said to be of *uniform* pitch. If it varies over the face of the blade the propeller is said to be of *variable* or *expanding* pitch.

In the case of small boats driven by gasoline or other like motors, it is often desired to avoid reversing the engine, and to this end the propeller is sometimes made with reversing blades. In such case they are usually two in number and are mounted in the hub in such way that by means of a lever their obliquity may be changed from right to left or *vice versa.* In this way the engine may be run always in one direction, while the propeller may be made to drive ahead or back as may be desired by an appropriate adjustment of the controlling lever.

Quadruple Expansion Engine. An engine in which the steam is expanded in four cylinders of continuously increasing volume, or in which the expansion of the steam is carried out in four successive stages. The first or smallest cylinder is known as the *high pressure* or *h. p.*, the second as the *first intermediate* or sometimes the *first m. p.*, the third as the second intermediate or *second m. p.*, and the fourth and last as the *low pressure* or *l. p.* The ratio of the volumes between the h. p. and l. p. is usually found between 8 and 10 in modern marine practice. This, with the usual point of cut-off in the h. p. and allowing for the influence of clearance, will usually give a total expansion ratio of from 12 to 15.

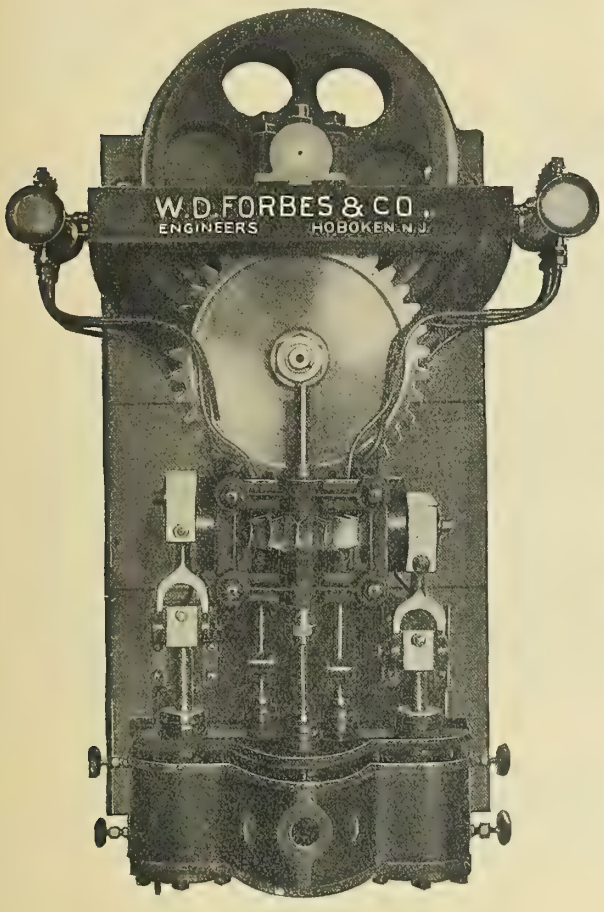
Speed of Torpedo Boats.--Owing to the difficult experienced by the builders of torpedo boat destroyers in attaining the contract speed of the vessels, the Navy Department has decided to reduce the required speed of boats built from departmental plans to 26 knots.

ENGINEERING SPECIALTIES.

New Type of Steam Steering Engine.

In looking over the subject of steam steering engines, but few types are found in the United States, while in England they seem to be very numerous. This seems not unnatural when it is remembered that English practice often demands that everything for a ship should be made in the yard or on the premises, while in America the work of specialists in various lines is generally purchased.

There is really as much individuality in design as in

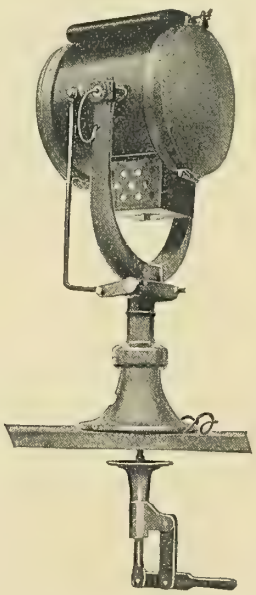


A NEW STEAM STEERING ENGINE.

persons, and there are many engineers who can tell at a glance where a piece of machinery is made, even if it is the latest product of the shop. Anyone knowing the previous designs of the W. D. Forbes Company, of Hoboken, might at once place to its credit the illustration herewith shown of a steam steering engine. This company has always held to well recognized and tested forms, modified for the particular conditions under which they are to be used, and its latest product is a very neat and satisfactory arrangement of mechanical details. The steering gear is arranged so as to be used either vertically or horizontally, the only change being in the modification of the oiling system, which is of the sight feed drip class. The cylinders of the engine are fitted with piston valves working in liners, the ports of which are machined, the floating or controlling valve being also of the same construction. The piston rods and crossheads are forged in one piece, and their brasses are fitted into slotted eyes with wedge adjustment. The connecting rods are treated in the same way on the crank-pin end, while on the cylinder end they are of the usual forked type, the crosshead pin being of generous size and of tool steel. The crank, eccentric and worm are all in one piece and of forged steel, and the bearings are provided with an adjustment for wear. This makes a very solid, yet light construction. The valve stems and eccentric rods are of steel, and the eccentric straps are of composition. The worm wheel is of bronze made to take up wear on the teeth by the well-known system of making the wheel in halves and providing a fine adjustment for same. All the bearings are very large and admirably oiled. The small worm wheel placed horizontally in front of the machine controls the floating valve and returns it to a natural position by meshing into the worm on the crank shaft, thus making an extremely simple arrangement. Throughout the engine Katzenstein's metallic packing is used, and the lagging is generally of copper. The W. D. Forbes Company has made several sizes of such steering gears, and adapted them for direct driving, when required, to the tiller head or for rope transmission, as is shown in the illustration. While this gear is stocky and strong in the extreme, it is light when compared with other types. Quite a number of these gears have already been sold, and seem to be very satisfactory. With these engines, when required, steering column and wheels are also furnished.

Search Light Projectors.

The advantages gained by the use of search lights on steamboats are becoming so well known that river



SEARCH LIGHT FOR PILOT HOUSE.

and harbor craft, as well as steamships, are often equipped with one or more projectors. In taking up buoys, in entering harbors and landing at docks, they lessen the difficulties of navigating at night.

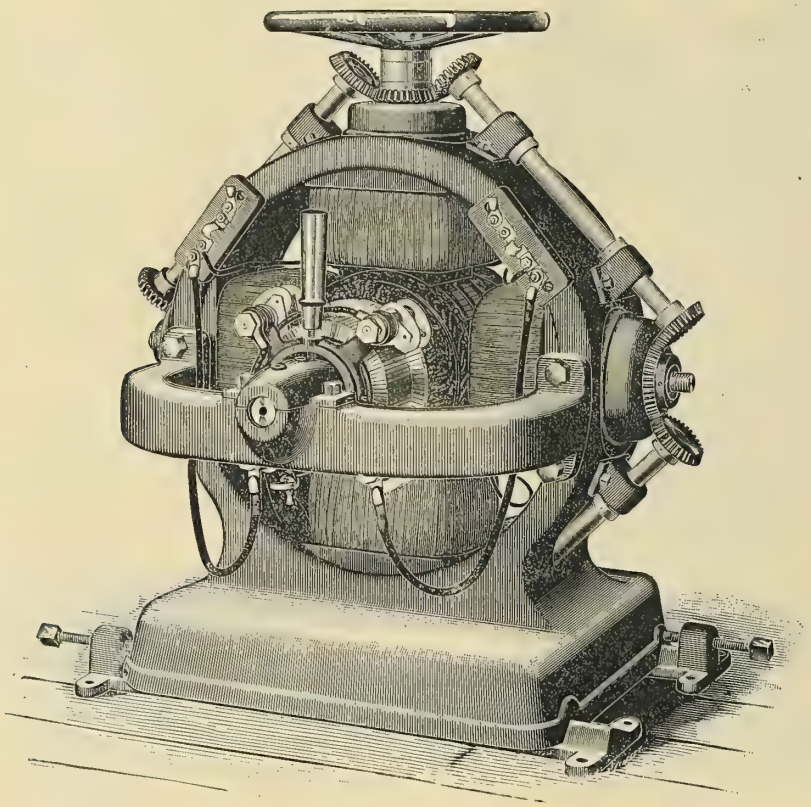
They are also a protection and an advertisement for passenger vessels. The pilot house lamp, here illustrated and manufactured by Enberg's Electrical and Mechanical Works, St. Joseph, Mich., is designed to meet these various requirements. The Mangin type mirror is used. This lamp can be either placed on the pilot house and operated by one handle from below, or, if desired, it may be placed at any point of the ship, and still be operated from the pilot house by cable system.

The Stow Multi-Speed Motor.

The new type of four-pole, "Multi-Speed" motor, illustrated herewith, combines all the advantages of the ordinary multi-polar motor, with the added advantage of an operative speed range of 100 to 150 per cent. from minimum speed, the percentage of speed variation increasing with the size of the machine. The armature rotates in a balanced magnetic field under all conditions of speed, this magnetic balance being secured by a simultaneous radial adjustment of the four "plungers" by means of bevel gearing, a hand wheel by which the plungers are moved being located conveniently at the top of the machine. The design of the pole pieces and the selection of gearing is such that no great effort is required at the hand wheel in order to move the plungers against the tractive power of the field magnets. As the gears are small and the gear rods lie close to the frame of the motor, this mechanism does not detract from the otherwise symmetrical and pleasing design of the machine. While the cut shows an open type machine, the design is such that if an inclosed motor is desired the armature supporting brackets may be removed and the ends of the frame finished so as to receive suitable inclosing heads, in the center of which the armature bearings are arranged.

The 6 H. P. machine, shown in the cut, is designed for a minimum speed of 700 R. P. M., the maximum speed being 1,500 R. P. M., giving a total speed variation of 115 per cent. at any speed, between which limits the machine develops its full rated H. P. with an efficiency of only 2 per cent. less at its maximum than at its minimum speed.

When the plunger is adjusted so that its inner end comes in contact with the pole shoe, the magnetic circuit is most complete and of minimum reluctance, and, since the M. M. F. of the field coil remains constant, the volume of magnetic flux becomes a maximum and the speed minimum, or normal. As the plunger is drawn away from contact with the pole shoe a column of air is interposed which gradually increases the reluctance of the magnetic circuit as long as the plunger continues to be withdrawn. When the plunger reaches the limit of its outward motion, the reluctance of the magnetic circuit, and hence the speed, becomes maximum.

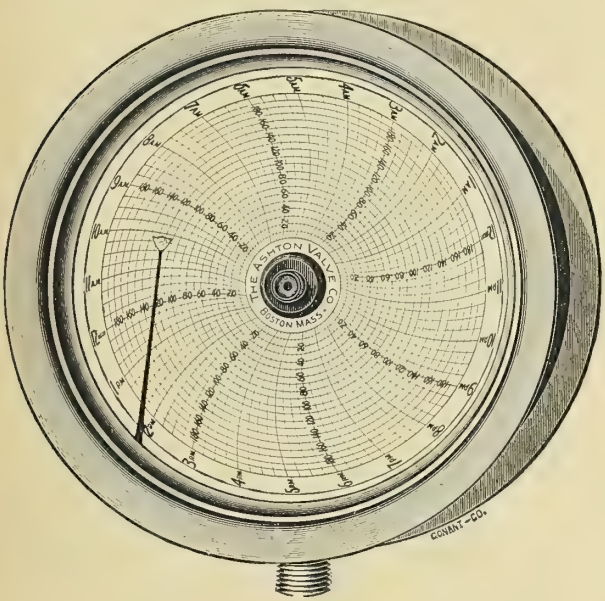


FOUR-POLE MULTI SPEED MOTOR.

It should be understood that while the motor carries its full load, sparklessly, at any imaginable speed within its range at practically maximum efficiency, it will also carry any lesser load with a consumption of power corresponding with the actual work done. As the speed regulation is effected solely by varying the reluctance of the magnetic circuits, no "controller" or rheostat or re-

sistance of any kind is used in the regulation of the speed, all electrical circuits and connections remaining unchanged through the entire range of speed.

The machine illustrated represents a type which is being built in sizes 5 H. P. up to 25 H. P. For sizes above 25 H. P. automatic means can be furnished for varying the speed. It is a fact worthy of emphasis that the special advantages offered by these motors are obtained without the sacrifice of any advantageous feature possessed by other machines of ordinary type, the efficiency being in every case fully up to the standard of first-class modern practice. It is interesting to note that in all other motors, the number of operative speeds corresponds to the number of steps in the controlling device, while the motor herein described possesses a speed range of absolute continuity; in other words, between the maximum and minimum limits an infinite number of speeds may be obtained without the use of any controller or rheostat. These motors are made by the Stow Manufacturing Company, Binghamton, N. Y.



A PRESSURE RECORDING GAUGE.

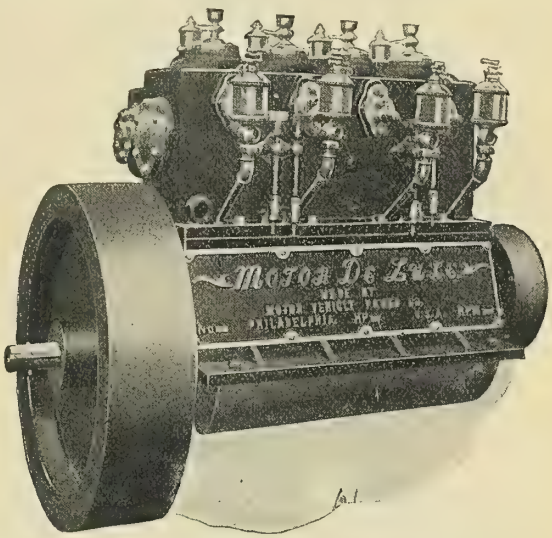
Recording Gauge.

The Ashton pressure recording gauge, illustrated in the above cut, is a combination of a pressure gauge and recording dial or chart. By its use a record is given showing the exact pressure carried, with its variations both day and night, with the time and duration of all changes. It is equally adapted for steam, water, air or gas pressure and is a most valuable instrument to have for any conditions in which a record of pressures is desired. When used at a boiler plant, these gauges serve as an incentive to careful firing and steady steam pressure, as any omission of duty or carelessness becomes recorded by the use of this gauge. The instrument is distinctly a high grade one. The clock movement actuating the dial is a fine instrument and is placed in an insulated case, so that should there be any leak in the gauge spring, the movement would not be injured. The dial is graduated for every 10 pounds pressure and every quarter of an hour, and is also figured so that one can tell at a glance while the dial is on the gauge what the actual pressure at the time is. The hours are also carefully marked A.M. or P.M. to avoid confusion.

The instrument is adapted for marine service and can be placed away from the boilers, in the pilot house, engineers' or captain's room or in all three. The gauge is made by the Ashton Valve Company, 271 Franklin street, Boston, Mass.

Motor De Luxe.

Simplicity, durability and strength, together with high efficiency and a large actual horse power per weight of machine, are claimed for the Motor De Luxe, which is made especially for marine purposes. This motor is made with four cylinders and is of the four cycle type. Gasoline is vaporized and led into the top of each of the four cylinders, the charge for all being regulated by one throttle valve. The cam shaft for operating the valves is geared to the main shaft and a different point



FOUR CYLINDER MARINE GASOLINE ENGINE.

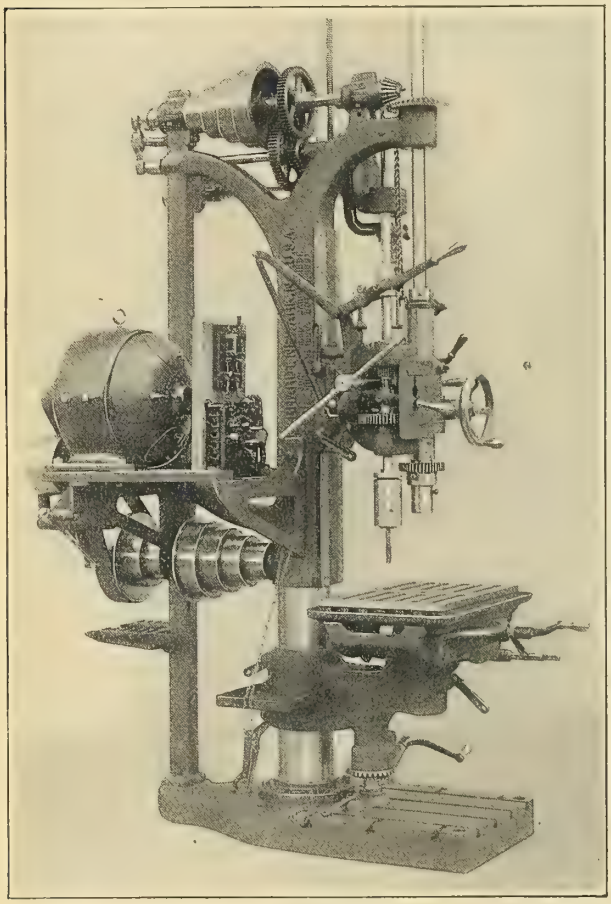
of cut-off is obtainable on all of the four cylinders. All the valves have positive motion. The sparking device for each cylinder is easily removable from the cylinders, and the point of sparking can be regulated. The tripping device for drawing the sparking has also motion from the cam shaft. The crank is a single forging, and the outer cylinders have their cranks set at 180 degrees from the two center cylinders, thus reducing to a minimum the vibration. An ignition occurs in a cylinder every two revolutions, so that in the four-cylinder type there are two impulses given to the crank at every revolution. These impulses, because of the crank angles, occur at equal intervals.

The motor is handsomely finished. A dynamo is supplied which can be thrown on in place of the batteries when the motor is under way. The three horse power motor has but two cylinders, and the larger motor has four cylinders.

Further particulars may be obtained by applying to the Motor Vehicle Power Company, 1221 Spring Garden street, Philadelphia, Pa.

Standard Drill Press.

The accompanying cut illustrates the latest improvements which have been made in the 25-inch upright power feed drill press made by Gould and Eberhardt, Newark, N. J. The illustration was made from one of a lot of machines which have just been shipped to the new United States Government Printing Office at Manila, P. I. The table and table arm are now raised by bevel gear and screw placed about central between the center of the column and the drill spindle, thus equalizing all strains and weights brought to bear on the table.



VERTICAL POWER FEED DRILL PRESS.

To the left of the drill spindle proper is shown the tapping attachment, which is used for tapping holes after they have been drilled, the work being rapidly moved across and centered under the tap by means of the oblong, compound traverse table. After it is set and started it will go to the proper depth, reverse and run back, and is ready again for the next hole. It is provided with a safety friction device which relieves the strain and prevents the tap from breaking should it strike the bottom of the hole or from any cause become fast in the work.

The method of arranging direct connected electric motor is also shown. The bracket which supports the motor is bolted to the upright columns of the drill and belted direct from armature shaft to driving pulley, and the switch for the motor has been placed where it can be quickly and conveniently got at by the operator. The table and base plate are large and sufficiently braced to maintain perfect rigidity of the machine. The column is practically one casting. The back brace to the column counteracts the pull of the cone belt, and thus prevents any possible springing or deflection of the column. An index placed over each step of the *lower* cone tells the operator the correct belt speed at which to run the various sized drills. An index placed under each step of the *upper* cone tells the operator what speed to run when back gears are engaged. This system not only eliminates guesswork and the burning of drills, but guards against "loafing" on the part of the operator. An index is also placed on the feed rod which tells at a glance the proper feed for any size drill within the range of the machine. The feed is entirely independent of the drill spindle, and changing the speed of the drill does not affect the feed arrangement.

An automatic stop and depth gauge throws out the feed after the drill has reached the required depth. The back gears are arranged so that one movement of a lever releases the cone from the shaft and engages the gearing. The spindle is provided with means for compensating all wear which may take place in the quill by means of a double conical bearing. Spindle head is vertically adjustable and can be raised or lowered and clamped in position. A square quill is used in place of the usual round sliding barrel. T slots run out to the edge of the table and base so that work can be bolted very close to the edge. The slots are of such a size that standard square-headed bolts will fit at once without having special ones forged.

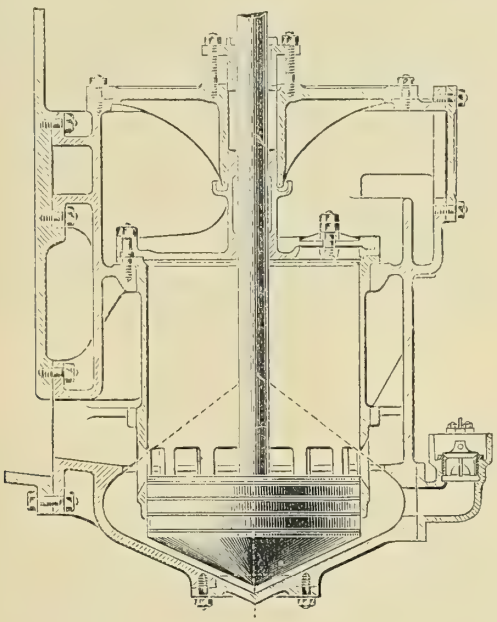
It can be made to feed either automatically or by hand, up or down, separately through the head the entire length of planed surface on column or independently through the rack on quill. All changes are made from the front of the machine, thus allowing the operator to remain in one position directly before his work. It is a rigid, accurate and substantial drill, and with proper care will last a lifetime.

The Edwards Patent Air Pump.

That the Edward Air Pump has been adopted by the leading marine engineers of Great Britain and has been fitted to over 500 vessels, many of them twin screws, is a sufficient endorsement of its reliability, economy and efficiency. In fact, for both marine and stationary purposes the total number of these pumps built exceeds 1,400. In this pump the prime requisites of a successful air pump are combined; namely, simplicity of design and construction, together with a very high standard of efficiency. The action of this pump is illustrated in the sectional view. It will be seen that no foot and bucket valves are used, the only valves being those that in other types of pumps are called head valves, but in the Edwards pump are called "the valves." The condensed steam flows continuously by gravity into the base of the pump, the plunger descends and uncovers the ports, admitting the air freely into the cylinder. The conical face of the plunger strikes the water, which is projected without shock through the ports into the

cylinder. The plunger then rises, closes the ports and sweeps the air and water before it, discharging them through the valves that are in the head of the cylinder. By this method of handling, the water is dealt with mechanically and its action is in no way dependent upon the pressure in the condenser, therefore an increase of speed does not impair its efficiency. In fact, very high speeds may be maintained.

In the old type of air pump, the pressure in the condenser has to be sufficiently above that in the pump to lift the foot valves, overcome the inertia of the water and drive it up through the valves into the barrel. The higher the speed of this type of pump the less the time between strokes and the greater the pressure required for



AIR PUMP WITHOUT FOOT VALVES.

operation; and as any increase in pressure in the condenser is accompanied by a corresponding increase of back pressure in the l. p. cylinder of the engine, it follows that any increase of speed of an air pump fitted with foot and bucket valves means loss of efficiency. Also with the old type, running at high speeds the discharge is apt to be very intermittent. It frequently happens that for several revolutions, while the pressure in the condenser is accumulating, no water is delivered; but when the pressure is sufficient to open the foot valves and drive the water into the cylinder, the pump has suddenly to deal with far more than its normal quantity of water, thus causing a series of violent shocks which often cause serious breakdowns.

In the old type of air pump the water has received first consideration and the air practically none. In the Edwards Air Pump the conditions are reversed. The question of satisfactorily dealing with the air so that no back pressure is produced in the condenser or l. p. cylinder has been considered of primary importance. Then the water has been dealt with in a most satisfactory, theoretical and practical manner.

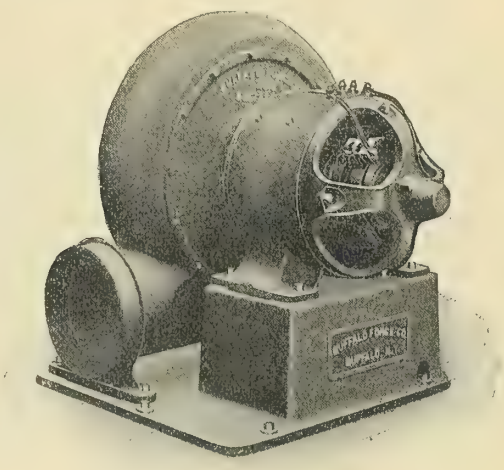
The mechanical features have been reduced to the utmost simplicity. There is but one set of valves placed on the outside of the cylinder, where they can be examined while the pump is in operation by opening the doors. The weir shown on top of the pump permits this examination without loss of fresh water, even in a heavy sea. Thus a thorough examination of all the valves is provided for without stopping the pump. The valve seats are each provided with a lip extending around the outer edge, so that each valve stands in its own water and is separate from the others. This forms a ready means of testing the relative tightness of each valve. The top clearance is reduced to a minimum, thereby considerably increasing the efficiency.

These pumps are arranged either single, double or three-throw; steam, electric, belt driven, or by levers from the main engine; slow speed or high speed, for use in connection with both surface and jet condensers.

The Wheeler Condenser and Engineering Company, of 120 Liberty street, New York, is the manufacturer and licensee for the United States of the Edwards Patent Air Pump, with full rights to grant licenses to others to build these pumps on a royalty basis.

Direct Connected Electric Exhauster.

The accompanying illustration shows one of the many interesting adaptations of electric apparatus so common in these days. It consists of a centrifugal fan or exhaust blower driven by a direct connected motor, for which service, by reason of the identity of motion of the driving and driven elements of the combination, the electric motor is peculiarly adapted. The constant resistance to the rotation of the fan wheel is overcome by a constant torque acting on the armature of the motor.



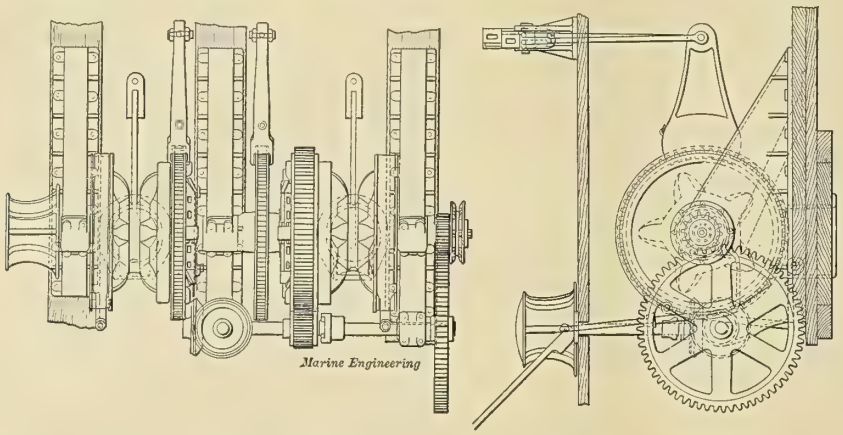
ELECTRIC DRIVEN EXHAUST BLOWER

The fan may be designated as a right-hand bottom, horizontal discharge exhaster, and is composed of a rotating blast wheel and a stationary casing. This casing consists of a circular discharge mouth piece cast with the circumferential rim, to which are bolted the two side plates. In the plate nearer the motor is provided the opening for the motor shaft, while in the other is located the circular air inlet. A distinction is usually made between blowers and exhausters, the lat-

ter having but one inlet, and the former having one on either side.

The blast wheel is built up of steel plate blades with backwardly curved tips, bolted to spider arms carried on a cast iron hub. The dimensions of these blades, as well as of the inlet and discharge openings, have been proportioned after careful experimenting, so as to afford maximum efficiency. The air enters the fan in a direction parallel to the shaft, passes outward along the blades with an increasing acceleration due to the centrifugal force, and is discharged radially from the tips with a velocity substantially equal to the peripheral velocity of the wheel. The pressure developed by a given fan varies as the square of the velocity, while the power expended varies as the cube thereof. The volume delivered is approximately proportional to the number of revolutions. Hence the loss entailed by using too small a fan and speeding it up to secure a given output is obvious.

The motive power of the fan shown herewith is a Lundell motor, manufactured by the Sprague Electric Company, and is of the enclosed type. A cast iron base supports the motor at the proper height. The fan itself is a product of the works of the Buffalo Forge Company, of Buffalo, N. Y., and it will be understood that the details of construction may be such as to allow the attachment of any standard motor. These fans are constructed in sizes up to No. 11 B, which requires 50 horse power, when developing 6 ounces pressure at 1,100 revolutions per minute.



A BRAKE WINDLASS USED ON LARGE SCHOONERS.

The Hyde Brake Windlass.

The cut on this page shows a plan and elevation of the Hyde brake windlass fitted on board the six masted schooners *Eleanor A. Percy* and *Geo. W. Wells.* The windlass is located on the main deck underneath the forecastle deck and is driven by 3-4-inch messenger chain from the 9 by 10 inch hoisting engine, located in the forward house. The chain pinion is shown on the starboard end of the windlass shaft. To this chain pinion is keyed a spur pinion driving a spur pinion free to turn, so arranged as to lock to the shaft by means of a clutch, as shown, and drive a spur gear keyed to windlass shaft. The windlass may be worked by hand power from the forecastle deck through pump brakes and levers. A gypsy end is keyed to the port end of windlass shaft for warping purposes or handling heavy loads. There is also a warping head of 20 inches diameter on the forecastle deck driven by bevel gearing from the countershaft of the windlass, and making about 10 revolutions per minute with the hoisting engine running at 250 revolutions per minute, while the gypsy head on the windlass shaft would turn about 2 1-2 revolutions per minute.

The windlass proper is mounted on three cast-iron bitts, as shown. The center and starboard bitts have a counterbearing cast on the after end for carrying the countershaft. This countershaft is 4 3-4 inches diameter, and the windlass shaft is 7 inches diameter. The bearings for both these shafts are lined with white brass. The bitts have wide flanges on the bottom and are provided with a suitable number of holes for bolting securely to the sills. Friction bands are fitted to each wildcat of ample strength and sufficient surface to ride by with the windlass unlocked. The friction bands operate from the forecastle deck by compressors, as shown. The wildcats are fitted for 2 3-4-inch stud link chain, and are locked to the shaft by means of a positive locking device worked by raised cams on the periphery of a locking ring and slotted block keys seated by a lever. Clutches are fitted to the upright shaft and countershaft, sliding on feather keys. By means of these clutches the warping head on the forecastle deck can be worked independent of the windlass, and also the windlass can be disconnected from the engine and operated by hand power. A chain clearer is fitted to each wildcat for stripping the chain in case it should become wedged in the wildcat.

These windlasses were built by the Hyde Windlass Company, and are the largest of this type ever built for a sailing vessel in this country.

Device for Launching Life-Boats.

The well known inefficiency of the present mechanism for handling and launching life-boats from ocean going steamers, and the loss of life resultant therefrom, has given rise to considerable thought on the part of many interested in the problem. The device as illustrated and described in the following article is claimed by the inventor to be, at least, a step forward in the proper direction.

The accompanying photographs of the model Nos. 1,

2, 3 and 4 represent the gear mounted and housed on the sun deck of a steamer, lifting cranes raised ready to lift life-boat from chocks, boat being swung over the side of the ship, and finally boat clear of ship being lowered to the water. The main points of advantage over the old gear claimed for this arrangement are first, the providing of a more perfect means to get the boats into the water quickly in case of accident; second, the

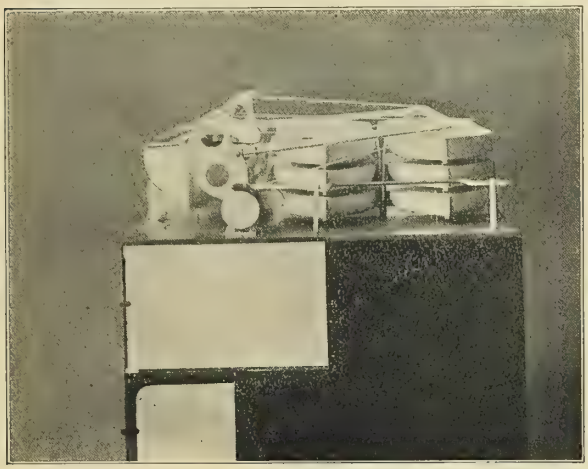


FIG. 1.

assurance that both ends of the boat shall be lowered equally; and third, the providing of means for quickly detaching the boat when in the water. A further object

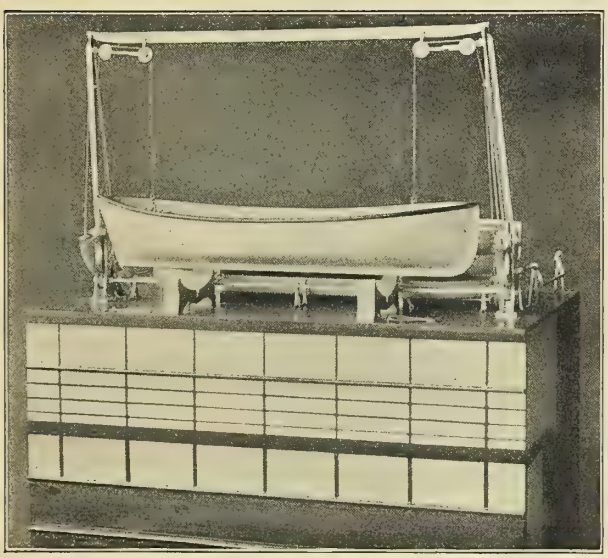


FIG. 2.

is to provide a launching device by means of which several boats may be launched from the same point and with people in the boats. These objects are attained by the following mechanism:

Two standards or brackets are fastened on the deck of the ship, and on the top of each on a short shaft a toothed quadrant or segmental gear is mounted, each supporting a derrick, in whose outer ends a beam is trunnioned, which with the stays of the derrick serves to steady the same and makes a very stable crane, the parts being proportioned in size and so disposed that a life-boat may pass freely between the derricks in the act of being launched. Through the lower parts of the standards another long shaft, running from one stand-

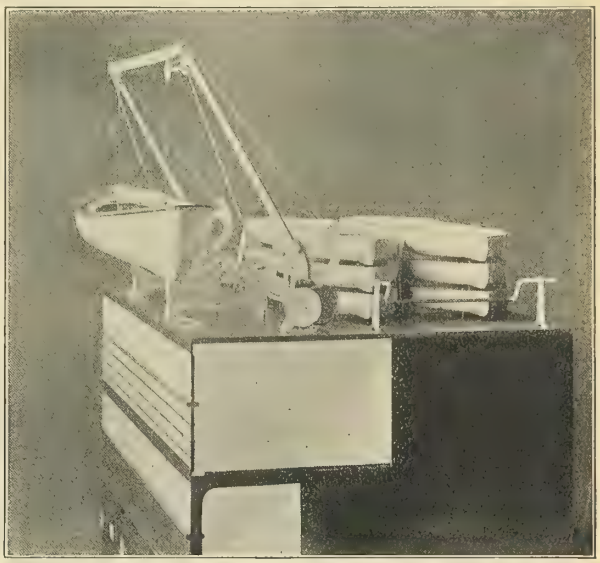


FIG. 3.

ard to the other, is passed, having two pinions mounted on it in mesh with the quadrants, and at one end of the shaft, outside of the bracket, another gear operated by a worm, which is in turn operated by a suitably sup-

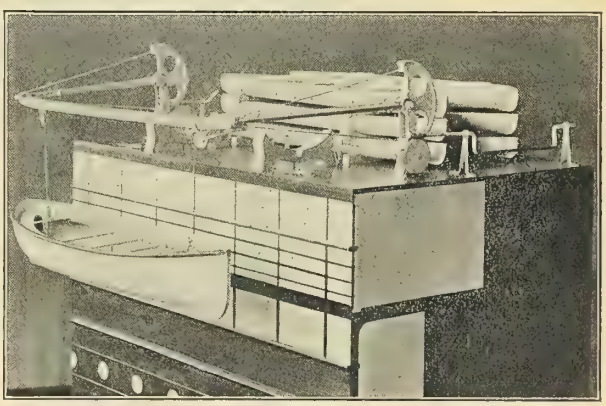


FIG. 4.

ported crank. As the pinions in mesh with the quadrants are secured to the shaft, the derricks will be operated in unison by turning the crank, and as the beam connecting the outer ends of the derricks is free to rotate, it will always maintain a vertical position. In the rear of the above mentioned shaft, another shaft, also having its bearings in the brackets and rotated by a similar arrangement of worm and wheel mounted on the opposite side of the one mentioned previously, is provided. On this shaft, at opposite ends, two drums

are mounted on which run the ropes leading to the detaching gear. It is therefore evident that by reason of the above mentioned construction both the crane and lowering device may be operated simultaneously so that when the life-boat is swung over the side of the vessel the boat can be lowered by continuing to operate the crane and lowering device, thus greatly expediting the launching of the life-boat, or vice versa. In order to keep the lowering ropes from being fouled by the life-boat in passing between the derrick, they are led through a series of ingeniously arranged pulleys attached to the brackets and cranes, as shown in the photographs. It will be easily understood that this arrangement permits the launching of a life-boat from the high side of a vessel having considerable list; in the case represented by the model this list amounts to about 20 degrees, depending, of course, on the length of the cranes, which again is limited by the weight of material permissible in the construction. This launching of a boat from the high side of a steamer is not possible by means of the present davits.

The detaching gear mounted in each life-boat consists of a series of rods, levers and links, so arranged that they are in absolute control of the officer of the boat, and in his control only. The attaching and detaching of the rings affixed to the ends of the ropes, doing away with the dangerous blocks, can only be done simultaneously, thus avoiding the oft recurring danger resulting from the release of only one end of the boat. Due to the weight of the boat on the detaching gear it is impossible to release the same before it is water-born, thus avoiding the great danger of premature release.

A diploma of honorable mention was awarded Wm. J. Kennedy, the inventor of the device, by the International Jury of Awards at Paris, where a model of the year was exhibited in competition for the Anthony Pollock prize. Mr. Kennedy's address is Pier 14, North River, New York City.

The Marine Cableway for Coaling Ship on the U. S. S. Illinois.

The first marine cableways for coaling ship were placed upon the collier rather than upon the ship to be coaled. The success of this method installed on the Lidgerwood-Miller system is well known, and in the most recent trials it has shown a capacity of 35 to 40 tons per hour, with the battleship towing the collier at a speed of 8 to 11 knots. The first warship to be equipped with a similar cableway is the U. S. S. *Illinois*. The chief advantage of this system is that it will permit the battleship to take coal at sea from any masted vessel which it may meet in any quarter of the globe. The equipment requires two special winches, Fig. 1, which have been so designed as to serve a special purpose. The winches originally located on the superstructure deck of the *Illinois* have been displaced by these two special winches, which serve all general purposes of the original machines, and in addition are adapted for operating the marine cableway when coaling at sea. In this manner there has been no essential increase to the machinery of the warship and no additional deck space has been required. The only additional equipment on deck consists of a few deck bolts, a coil spring at the masthead, and two levers conveniently located on the after bridge. Just below the steering compartment and beneath the platform deck the remainder of the equipment is located. A reel suspended from the deck carries 2,000 feet of 7-8 inch sea anchor line. There are also two 3-8-inch conveyor lines and two sea anchors. There are also the haul-down block, carriage blocks, etc., all of which occupy a space just below the deck, 16 feet long, 7 feet wide and 4 1-2 feet deep. The coil spring attached to the mainmast will be completely compressed under a load of 20,000 pounds, but a strain of 12,000 pounds only is developed in carrying a load of one ton. As the warship pitches and ascends, this spring will compress and elongate, thus serving to equalize the somewhat varying strain on the sea anchor. The arrangement of the blocks

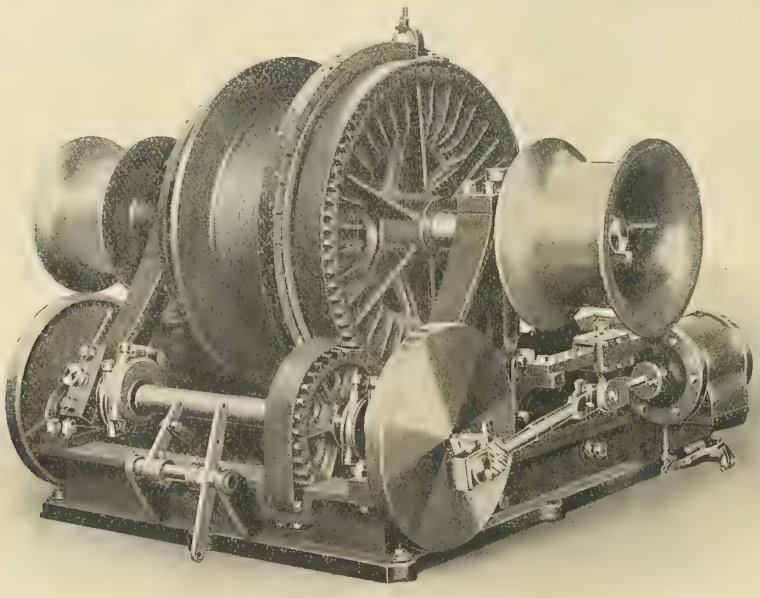


FIG. 1—SLIPPING DRUM WINCH ON U. S. S. ILLINOIS SERVING FOR BOTH COALING AT SEA AND BROADSIDE IN HARBOR.

and lines is shown in the accompanying figure. After the sea anchor has been located and the sea anchor line made taut, the tail block, shown in Fig. 2, is hauled over and attached to the mast of the collier. This carries with it the conveyor line from one of the winches. At a point above the sea anchor line another lashing is

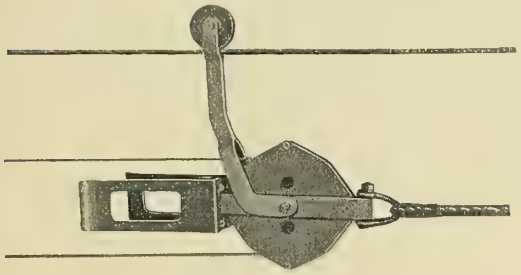


FIG. 2.—TAIL BLOCK.

made and two 3-4 inch wire guy ropes are there attached and led forward on an incline to the starboard and port sides of the ship, where they may be attached to the

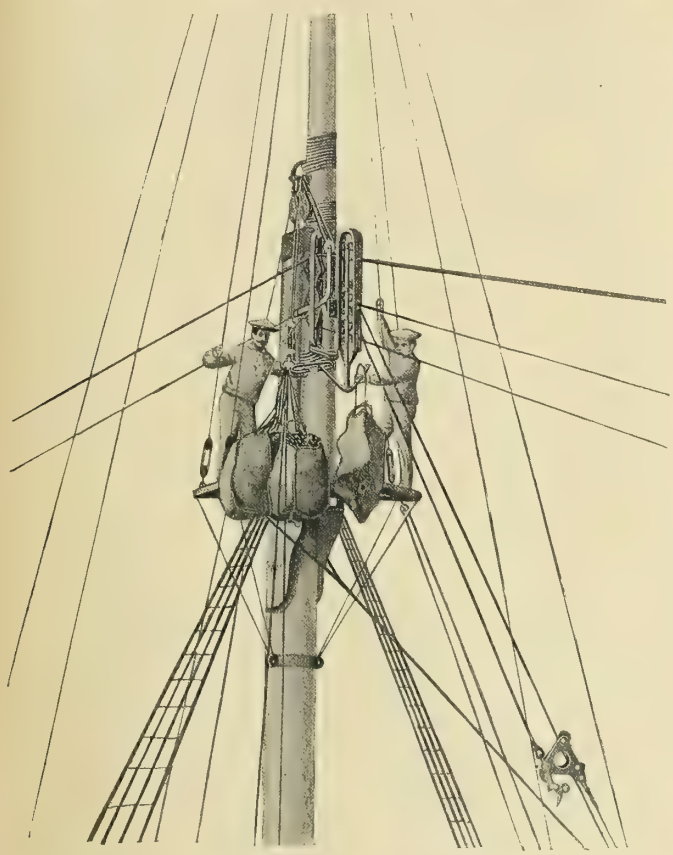


FIG. 3.—TRANSFERRING LOAD AT COLLIER MASTHEAD.

deck at almost any place found convenient. On these two inclined stays will run the two little elevating trucks, weighing only 37 pounds each, as shown in Fig. 4. Loads of one ton can be hoisted from the port deck and then the starboard deck, in alternation, to the masthead, where two men are located, as shown in Fig. 3. One of these men takes in his hand the loose ring which is a part of the elevating hook. When the cableway carriage (Fig. 5) reaches the collier's masthead the ring is placed by hand over the hook of the carriage, a lever is pulled on the elevating truck, and the load is dropped and thus transferred to the cableway carriage. This operation, by actual time, has been accomplished in two seconds. The other man at the masthead will take off the empty bags as they return from the warship and send them to the deck for refilling.

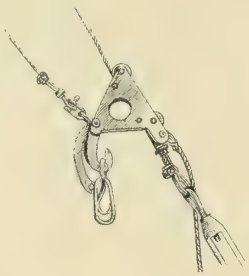


FIG. 4.—ELEVATING TRUCK.

With the present arrangement the load starts out from the collier on a down hill route and continues so for more than half the distance. When the load is just clear of the center of the span and in its lowest position the man on the warship commences to pull down the

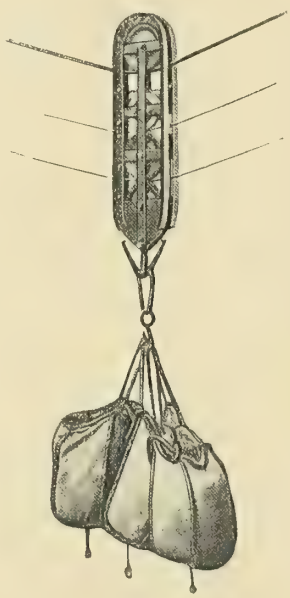


FIG. 5.—LOAD CARRIAGE.

haul-down block, and by the time the bags reach this block they will be trailing on the deck. The operator then stops for an instant, lowering continues for a foot or more, the load is unhooked from the carriage, the empty bags put on and the whole lifted to its normal position. At the same time the operator sends the empty carriage back to the collier for another load. The capacity of this equipment should be 60 round trips per hour, and the quantity delivered should not be less than 40 tons in the same time. The chief limiting factor in

the capacity will be the ability of the men on the collier to feed the cableway.

By having our warships thus equipped the question of coal supply is largely solved, and solved with less cost than in any other way, since they can coal direct from any collier and are not dependent upon coaling stations.

Our navy needs a few colliers in peace times, and a great many in case of war. Any masted ship, either sailing vessel or steamship, can do duty as a collier and deliver its coal at sea to any warship equipped with a Marine Cableway. All colliers should also be fitted with Marine Cableways when time permits. Such colliers, however, should be fitted to deliver coal to the smaller warships in tow of the collier. Even a destroyer could be coaled at sea by a collier properly equipped.

The Marine Cableway thus installed is intended to permit a fighting vessel to remain in the fighting line. It is intended to permit a fleet of war vessels to arrive off the coast of the enemy with their bunkers full instead of empty. Another phase of the question relates to the possibility of the United States becoming involved in war with a foreign power. In such case the merchant ships and coal carriers would probably fear to leave the home ports because of their liability to capture, and it is probable that the government would have offered to it an abundance of such vessels as coal carriers, at favorable prices, whether for purchase or for charter.

Converting Ships for the Oil Trade.—Many of the shipyards of the Atlantic and Pacific coasts are busy transforming steel ships into oil transports.

Trial of the Truxton.—The torpedo boat *Truxton,* nearing completion at Sparrow's Point, Md., was given a builder's trial recently in Chesapeake Bay at which a speed of 27.75 knots was attained.

Shipbuilders Busy.—The shipbuilders of New England and of the maritime provinces are enjoying a period of great activity this year following upon the successful business in 1901. There are building or under contract in these sections 182 merchant vessels of over 100,000 tons.

Ten Months' Shipbuilding Returns.—The Bureau of Navigation reports 1,072 sail and steam vessels, of 329,499 gross tons, built in the United States and officially numbered during the ten months ended April 30, 1902. During the coresponding ten months ended April 30. 1901, 881 sail and steam vessels of 310,132 gross tons were built in the United States and officially numbered.

A New Magazine.—A new magazine, called the *Maritime World,* has been started in San Francisco. This publication contains many interesting items under the heading of the Month's Log Book, and the leading articles of the month cover the topics of present interest in the maritime field and treat of such subjects as the Ship Subsidy bill, the new turbine steamer, lake and ocean traffic, etc. Several pages are devoted to commercial and marine notes, and news concerning the New World Markets. Under Flotsam and Jetsam are given items of interest to shipbuilders. The *Maritime World* is well printed on good paper and the 36 pages of reading matter are a credit to the publishers, the Maritime World Company, 22 Clay street, San Francisco, Cal. The price per year is $3, and per copy 35 cents.

THE PROFESSOR ON SHIPBOARD.

Story of an Attempt to Combine Theory With Practice.

BY C. A. MC ALLISTER, FIRST ASSISTANT ENGINEER, R.C.S.

CHAPTER X.

On the following day the Professor spent the greater part of the morning lolling about under the awnings and in reading. The fact of the matter was that the prevailing temperature was having its effect on him, and he had reached that stage where he was losing his ambition to keep employed at something useful. At about ten o'clock he joined the 1st Officer on the bridge, and watched him taking a sight with the sextant, or "shooting the sun," as the officer expressed it. Although the Professor had never actually taken a sight he was more or less familiar with the theory of navigation and very readily followed the officer's calculations for a time sight. The air of mystery and superiority which the deck officer assumed during this operation was very amusing to the college man, for the calculations were so simplified by reference tables that anyone with even a rudimentary knowledge of trigonometry could easily learn as much navigation as the deck officer possessed, in a very few lessons. In fact he quite astonished the navigator by pointing out to him several methods of shortening his calculations, which he reluctantly acknowledged were improvements. The Chief Engineer, who happened along at that time, seemed also somewhat agreeably surprised that his younger brother possessed so much knowledge of a subject in which he himself was entirely lacking, although he had spent many years at sea.

The Professor explained to him that any man educated in a technical school could easily grasp such subjects, as his mathematical training fitted him for just such work. To this the Chief replied that a technical education was undoubtedly a good thing to have, but how, said he, can a young man who has to hustle for a living from the time he is fourteen years old, ever expect to get a college education? The Professor remarked that he was glad to have that subject brought up, and went on to state that to obtain an education in the engineering profession it was not absolutely necessary to attend a college.

"It does not make a particle of difference whether a young man is a graduate of a technical school or not; it is what he can do that determines his standing and fixes his salary. There are just as competent men in the profession to-day who obtained their education by their own efforts, as there are who have graduated from colleges. Of course, everything else being equal," he continued, "the college man has the advantage at the start, but in actual work the man who uses his brains and skill to the best advantage in his employer's interest, will eventually go to the front whether he is a graduate or not. In this connection the Chief asked his brother what his opinion was of the various correspondence schools which are now so extensively advertised. To this interrogatory the Professor replied that he considered them as excellent institutions.

"Why," said he, "one of my colleagues at the university where I am employed originated the correspondence instruction idea, and I am very much pleased

to see how successful it has proven to be. In this way hundreds of young men are being greatly aided in their efforts to obtain an education. As the attainment of that end is entirely due to a man's own efforts, there seems to me to be no reason why any young man, and especially oilers and junior engineers on board ship who are ambitious to succeed in their profession, should not be greatly helped by joining one of these schools. Of course," said he, "I am a firm believer that young men with the necessary means should attend technical schools, but if they are not able to do so, the next best procedure is to get as much help as they can in this modern method. They can then earn their own living, and spend part of their spare time in studying. I understand," he continued, "that there are numerous cases where young engineers have been materially advanced in their business through the help of a course of studies as mapped out by some of these correspondence schools."

After luncheon that day the college man stretched himself out in an easy chair and, like a good many of the passengers, he enjoyed a siesta. When he awoke he was approached by the 1st Assistant, who remarked that he was glad to see him enjoying himself.

"Yes, I am getting quite lazy," said the Professor, "and if the engineer's crew all felt as I do I am afraid that the ship would come to a standstill until all hands had taken a nap."

The Assistant reminded him of his promise to explain something more about indicator cards.

"Oh, yes, so I did," said the man of figures. "If you will get me those cards I took last evening and a scribbling pad I will see what I can do with the subject."

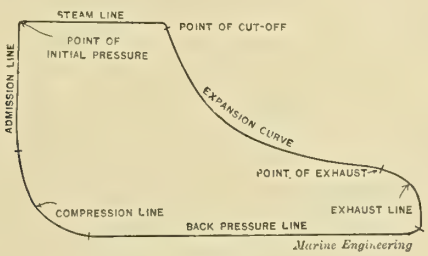


FIG. 1.

The Assistant promptly went down in the engine room, and after obtaining the desired articles, brought them up on deck. He was soon joined by the Chief, who remarked that as he was a little shy on the subject he would like to hear what his brother had to say.

Taking up the subject the Professor stated that he supposed they were quite familiar with indicator cards, and apologized in advance if he should attempt to explain anything which they already knew.

"Now that we have taken a set of cards from the high pressure cylinder, it would, of course, be well if we had several sets from each of the other cylinders, but for purposes of illustration the high pressure cards will do very well. As you probably know, an ideal card should look something like this: (See Fig 1.)

"On this card I will mark the names of the different lines and points, which it is always well to remember when discussing this subject. As you can easily see, the actual cards which we took last evening differ considerably from the card which I have sketched, due to many causes. For instance, on the ideal card the admission line is shown very nearly perpendicular, and, in fact, it should be exactly so. If it inclined inward, and the indicator was correctly adjusted, you could feel positive that the valve was so set that the steam was admitted too late. If, on the other hand, the admission line was inclined outward, the valve would evidently be admitting the steam too soon.

"The greatest discrepancy is liable to exist in the expansion curve. This curve follows nearly the shape of a hyperbola. It is often found, however, that the terminal pressure at the end of this curve is higher than it would be with the usual law of expansion. This is largely due to the fact that almost all steam valves leak steam into the cylinder after the point of cut-off has been reached.

"Sometimes, too, it will be found that the curve runs lower than might be expected. This state of affairs is due generally to the fact that the engine piston and the exhaust valve leak. At times cards are obtained wherein this curve is apparently correct, but it is not always safe to assume that because of that effect the valves and piston are tight, as the leakage through both may be just sufficient to compensate each other. You may have observed that the expansion curve is sometimes wavy; this condition is generally caused by water in the indicator cylinder, or to an excessive amount of vibration of the instrument. There are numerous other defects that I might point out to you in connection with indicator cards, but in general it should be the aim in designing an engine, and in adjusting the valve gear, etc., to give a card with the following general features:

"1. The steam line should be as nearly paralled to the atmospheric line as possible, and it should be nearly as high as the line drawn to the scale and representing the pressure in the boiler. This result shows that the steam pipe is sufficiently large; that there is no undue friction in the stop and throttle valves and main steam pipe; also that the steam ports and valve openings are of sufficient size.

"2. The expansion curve should be nearly hyperbolic, showing generally that the valves and piston are tight.

"3. The admission line should be nearly perpendicular to the atmospheric line, showing that the steam is admitted to the cylinder at exactly the right time.

"4. The back pressure line should be parallel to the atmospheric line, showing that there is a sufficient opening of the exhaust valve.

"5. The point of cut-off, point of exhaust opening and point of exhaust closing should theoretically be clearly defined, but in practice, owing to the gradual opening or closing of a slide valve, they are generally represented by curved lines."

At the conclusion of this part of the Professor's dissertation he looked up and somewhat to his chagrin saw the Chief with his eyes closed and slightly nodding his head. Upon being accused of sleeping, he quite indignantly denied the charge and said that he was simply trying to memorize what the Professor was

saying. Considering the closeness of the afternoon the Professor felt inclined to doubt his brother's assertion.

"I wouldn't blame you much if you were asleep," he continued, "as this is a somewhat dry subject. Now if you will keep your eyes open for a few moments I will try to show you something about working up cards to determine the power developed by an engine. The first thing I want to impress on you is to clearly understand the term 'power'. Many people use the terms 'work' and 'power' as synonymous. As a matter of fact they do not have the same meaning at all. For instance, if you carry a weight of 10 lbs. up a flight of stairs 20 feet high you have performed work to the amount of 200 foot pounds. That is, work consists of two elements only—force and distance.

"To determine the 'power' you used in carrying up that weight you must take into consideration the time you spent in going up the stairs. That is, power consists of three elements—force, distance and time. In the early days of the steam engine, it was of course found necessary to establish a method of stateing the power developed. The horse being one of the most useful and universal beasts of burden, the engineers of that day naturally based their comparisons of the power of engines on that of horses. Accordingly a series of experiments were made with some powerful London dray horses, and it was determined that the average power of these horses was equivalent to lifting 1,000 pounds through a height of 33 feet in 1 minute, or 33,000 foot-pounds per minute.

"This was then adopted as the unit of power for the steam engine. It may interest you to know, however, that the average horse cannot raise a weight of 1,000 pounds a distance of more than 27 feet in a minute. That is, they can only develop a little over 80 per cent. of the so-called horse power. Now then, to find the power developed by an engine, we must determine just three elements. The time and distance are easily ascertained by noting the number of revolutions made by the engine in one minute. The actual distance traveled by the piston is of course equal to twice the number of revolutions, as it goes up and down in one turn of the engine. Thus your engine here has a stroke of 36 inches, and is now making about 110 revolutions per minute.

"Remembering that the distance must be expressed in feet, you see that the piston travels 3 feet down and 3 feet up, or 6 feet in one revolution and 660 feet in one minute at the speed of 110 revolutions. This 660 feet is known as the 'piston speed,' and, by the way, that is rather slow for a modern engine, as nowadays a piston speed of 900 to 1,000 feet ought to be obtained on all first-class passenger vessels.

"The other element, 'force,' is somewhat more difficult to determine, and here is where we use the indicator card. As you know, the spring of an indicator is so proportioned that the height of the steam line and the expansion curve show at any point the pressure of the steam on the piston, when measured by a scale proportioned to the spring. As this varies at nearly every point on these lines it is necessary to obtain the average height and consequently the average pressure on the piston during the entire stroke. There are several methods for ascertaining this average height. The best method is by the use of an instrument known as a planimeter. This is an instrument such that by running a pointer all around the card the exact area inclosed can be read from a cylindrical scale, with a vernier attachment. It is usual to take the average of two or three readings of this scale in order to minimize the chance of error. Knowing the area of the irregular figure, and the length, the average height is readily determined by dividing the area by the length. If you do not happen to have one of these instruments the average height may be approximately determined by the following method: Divide the diagram, as shown in Fig. 2, into any number of equal parts, say ten for convenience, by drawing lines perpendicular to the atmospheric line. Then subdivide each one of these parts into two equal parts, as shown by the dotted lines. Measure each dotted line with a scale graduated to correspond to the spring used in the indicator. Add together the lengths of these dotted lines and divide by 10, and the quotient will be the average height, or the mean effective pressure.

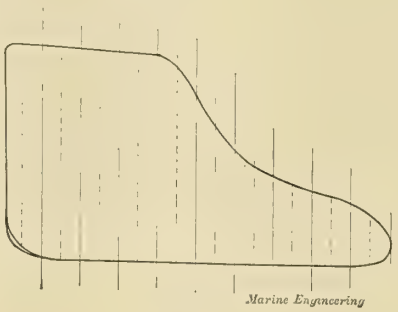


FIG. 2.

"A convenient method of measuring these lengths is to take a strip of paper and mark off on its edge each length, one following the other. The sum of all the lengths or ordinates, as they are called, can therefore be determined by simply measuring the distance between the extreme points with the scale used. Knowing the average pressure exerted on the piston during its entire stroke, it is only necessary to multiply it by the area of the piston expressed in square inches to determine the third element of 'force' for the calculation of the power.

"In estimating the power, you must not lose sight of the fact that as the piston rod comes through the bottom of the piston, an allowance must be made for its area. Thus the high pressure cylinder of this engine is 30 inches in diameter, and the piston rod is 5 inches in diameter. The area of 30 inches diameter is 706.86 square inches. This area is correct for calculating the power during the down stroke; but on the up stroke the rod must be taken into account. Thus the area of a 5-inch circle is 19.63 square inches and 706.86 — 19.63 = 687.23, the area to be used for calculating the power developed on the up stroke. It is usual as a matter of convenience to take half the area of the rod from the total area of the cylinder, and to use this area for cal-

culating the power developed in one revolution, or two strokes. Thus ½ of 19.63 = 9.86 and 706.86 — 9.86 = 697.00 square inches in the area to be used.

"The old formula of P. L. A. N. ÷ 33,000 is very convenient to memorize, but it is too often used without knowing its meaning, and I hope that I have made it clear to you. Thus you will see that the factors P and A are necessary for determining the element force; N and L determine the elements of time and distance. I know that I have gone over a great deal of matter that is already familiar to you, but it won't do any harm for you to review it, and I hope that I have brought out some new ideas of the subject for you."

The Chief Engineer, who had kept awake during the latter part of his brother's talk, thanked him for what he had explained to them, and said that he had been much interested. The 1st Assistant said the same thing, so the Professor did not think that his time had been entirely wasted, although he felt doubtful as to whether he had imparted any new information to his listeners.

TECHNICAL PUBLICATIONS.

Easy Lessons in Mechanical Drawing and Machine Design, arranged for self-instruction by J. G. A. Meyer and Charles G. Peker. Two volumes. Size 9½ by 13 inches, pages 680, with upwards of 750 illustrations and several full-page plates. New York, Industrial Publication Company. Price $11.50.

Volume I of this large work, together with about three-fourths of Volume II, had been completed by the author at the time of his death in 1900. In accordance with the wish of the author the work as a whole was carried forward to completion by the assistant author who had been associated with him in the work and who therefore had full access to the author's manuscripts, drawings, etc., and who was furthermore thoroughly conversant with the character and purpose of the work as it lay in the author's mind. The two volumes are therefore to be taken together as a single work intended to give instruction in Mechanical Drawing as applied to Machine Design, together with information regarding the field of Machine Design in itself. The purpose of the author was furthermore to so present this matter that it should constitute a self-instruction book and serve therefore the needs of those desiring to advance themselves in the knowledge of drafting and design, but unable to obtain the advantages of regular instruction in these branches.

The work as a whole is divided into sixteen chapters. The earlier chapters relate naturally to the geometrical principles involved, which are illustrated by many practical examples. The description of ordinary drafting instruments, together with methods of their use, also find treatment in this part of the work. In the later chapters applications of Descriptive Geometry to drawing are given, together with special discussions of points relating to Mechanics as applied to Machine Design. A large amount of information in the form of rules and empirical formulæ for design is also given, but without that relation to their rational basis in Mechanics which would be desirable in a book of design. Distributed throughout the work are numerous examples of machine drawing and design, illustrated by various machine tools, parts of steam engines, pulleys, gearing, etc. These drawings are well executed and well reproduced, and form perhaps the most satisfactory part of the book.

The feature of the work as a whole which seems to call for some criticism is that of the arrangement and mode of presentation of the subject matter. Examples of advanced machine design are distributed throughout the work without regard to their relative difficulty or to the principles of design which are involved. Thus complete drawings of a 16-inch engine lathe are presented and discussed to some extent in the first chapter of the work, and in advance of any consideration of drawing instruments or their use, or the elements of geometrical and mechanical drawing. Similarly with regard to the rules and methods of design, they are distributed throughout the work without logical arrangement, and any given item can only be discovered by reference to the index at the end of the work.

With a somewhat more logical and orderly presentation of the subject matter of this work we believe that it is one which would be found of great value for that class of draftsmen and designers for which it was especially intended.

The Indicator Handbook, a practical manual for engineers. Part II. By Charles N. Pickworth. Size 4½ by 7¼ inches, 132 pages with 148 figures in the text. New York, D. Van Nostrand Co. Price $1.50.

This volume is Part II of the work published by the author under the above general heading. In Part I the construction and application of the indicator were dealt with in detail, and the subject was taken up chiefly from the standpoint of what might be called indicator practice. The present volume is intended to complete the work as a whole, and is devoted to the analysis of the indicator diagram and to the various computations based upon it.

The work is divided into seven chapters with an appendix. The first chapter gives a general discussion of the preliminary considerations and definitions bearing upon the problems which are to be studied. In chapter two the diagram is discussed in detail, and special attention is given to various modifying and disturbing influences and their results upon the diagram. In chapter three the analysis of the diagram is undertaken, special note is given to its application to the usual problems of valve setting with the interpretation of unusual types of diagrams. Chapter four deals with diagrams from compound engines and their combination and interpretation. In chapter five diagrams from gas and oil engines are considered with the same general detail and care as with steam diagrams in the preceding chapters. Chapter six deals in a similar manner with diagrams from air and ammonia compressors, pumps, etc. In chapter seven the usual calculations for mean effective pressure and indicated horse power are discussed. The use of the planimeter in its various forms is also described, and a clear presentation is given of the principles bearing upon these calculations.

Taken as a whole the book forms a valuable supplement to Part I, and the two together provide an excellent guide to the manipulation and application of the instrument, and also to the intelligent interpretation and use of the diagrams which it is intended to furnish. These features are sure to make the book of high value to the

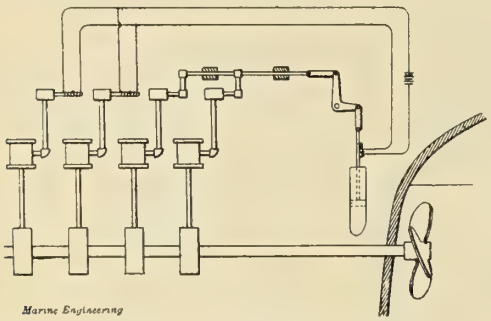
practical engineer, and it may be confidently recommended to all such as a convenient and instructive handbook regarding this field of engineering practice.

SELECTED MARINE PATENTS.

696,972. SUBMARINE BOAT. JOHN P. HOLLAND, NEWARK, N. J.

696,982. TIDE-MOTOR. FRANK H. LAUTEN, BROOKLYN, N. Y.

697,053. BRAKE FOR PROPELLER-SHAFTS. GEORGE WHITTLESEY, NEW LONDON, CONN.



CLAIM.—1. In a device for preventing racing of marine engines, a float subjected to variation in water-pressure near the propeller, valves controlled by said float governing means for applying a resistance to the rotation of the propeller.

CLAIM.—8. A governor for a marine engine comprising a brake mechanism for the propeller-shaft, said brake being actuated by a fluid-pressure, said pressure being in turn governed by a float, the fluid-pressure being independent of the power of the float. Ten claims.

697,202. MECHANISM FOR TRANSFERRING BOATS. LEON DONNE, CHICAGO, ILL.

CLAIM.—1. As a means for moving boats from one level to another the combination of two shafts provided with wheels, one of said shafts being located below the level from which the boat is to be moved, and the other shaft at a higher level, an endless belt or apron provided, arranged around the wheels on said shafts and provided with supports for the boat, and means for preventing a sagging of the carrying portion of the endless belt or chain. Four claims.

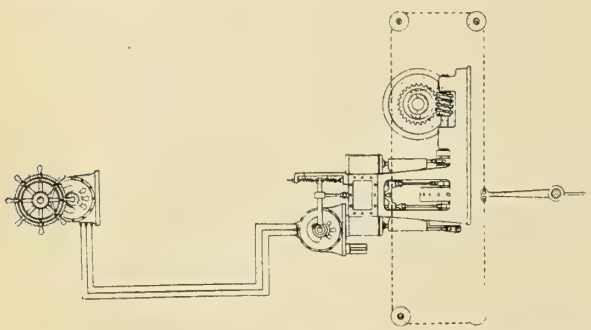
697,359. APPARATUS FOR LAUNCHING LIFE-BOATS FROM SHIPS. CHRISTIAN F. PETERSEN, WILMINGTON, DEL.

CLAIM.—1. In boat-launching apparatus, the combination of a permanent overhead track with support, a swinging continuation of same with stay and guys, a truck as a means of transporting boats from the permanent track to the end of the swinging track. Five claims.

697,539. BOAT. CHARLES S. PRUDEN, ROME, GA.

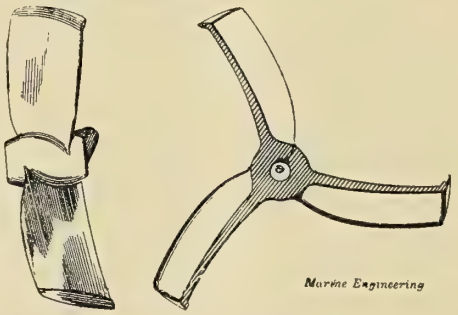
697,712. PADDLE-WHEEL. HENRI GLARDON, GALVESTON, TEX.

697,826. ELECTRICAL STEERING APPARATUS FOR SHIPS. BRADLEY A. FISKE, U. S. NAVY, ASSIGNOR TO WESTERN ELECTRIC COMPANY, A CORPORATION OF CHICAGO, ILL.



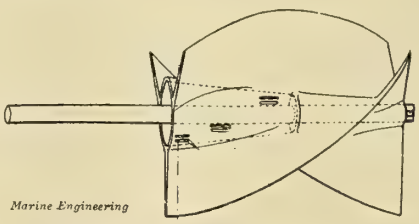
CLAIM.—1. In an electrically-controlled steering apparatus, the combination with a helm of an electric motor device and mechanism associated therewith for moving the helm, a hand steering-wheel, and a generator of electricity having an armature or rotor adapted to be turned by said steering wheel and connected with the motor device, whereby the helm may be controlled by moving said steering-wheel, substantially as set forth. Five claims.

698,582. PROPELLER-WHEEL. EDWARD E. STROTHMAN, WEST SUPERIOR, WIS.



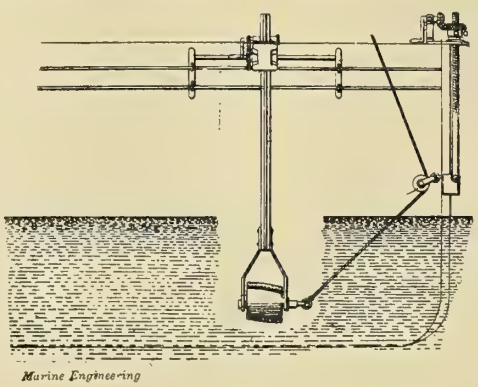
CLAIM.—1. A propeller-wheel, comprising a hub, blades radiating therefrom and each set upon an angle with relation to the longitudinal axis of the hub, each of the blades gradually increasing in width from its line of jointure with said hub for a comparatively short distance, and from thence to the outer end being substantially of uniform width and curving laterally rearwardly and having its front face convex, the rear face of the blade being substantially flat, and the blade being comparatively thick near its base and tapering to its outer end, substantially as described. Four claims.

698,584. SCREW-PROPELLER. ROBERT THALER, WEST BAY CITY, MICH.



CLAIM.—A propeller for vessels comprising in combination a series of helical blades of greater length than the diameter of the propeller; a hub integral with said blades; an axial hole through said hub, the outer portion of the length of said hole being adapted to fit the propeller-shaft; the remaining portion of said hole being enlarged from the middle of the hub toward its forward end, to form a conical recess; openings through the conical shell of the hub; and scraping-bars across said openings; together with a conical rearwardly-extending bearing secured to the vessel and fitting the conical recess of the hub, said bearing having an axial shaft-opening, all arranged substantially as and for the purposes set forth.

699,144. MEANS FOR CLEANING SHIPS' HULLS. WALTER S. BURT, ALBURY, NEW SOUTH WALES, AUSTRALIA.



CLAIM.—1. In a mechanism for cleaning a ship's hull, the combination of a curved carrier-rod, a revoluble cleaning-cylinder mounted on the foot of said carrier-rod and provided with external cleaning elements, and means for adjusting said cleaner-cylinder lengthwise of, and vertically with respect to, a ship's hull. Eight claims.

699,231. BOAT. JAMES P. POOL, BROOKLYN, N. Y.